CAL POLY

Fire Protection Engineering

Prescriptive and Performance Analysis of Cold Machine Shop

FPE 596 Culminating Project

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Keywords: Life Safety Code, Performance-Based Design, Fire Dynamics Simulator (FDS), Fire Modeling

Executive Summary:

The purpose of this report is to analyze the fire and life safety aspects of the Cold Machine Shop located on the central coast of California. This report includes both a prescriptive and performance based analysis.

The prescriptive analysis will evaluate the building as follows, to ensure compliance with standard codes:

- Egress analysis and design using NFPA 101, "Life Safety Code"
- Fire detection, alarms, and communication systems using NFPA 72, "National Fire Alarm and Signaling Code"
- Water-based fire suppression systems using NFPA 13, " Standard for Installation of Sprinkler Systems" and NFPA 14, " Standard for the Installation of Standpipe and Hose Systems"
- Structural fire protection using the International Building Code

Based on the results of the prescriptive based analysis of this building, only one issue was found with the building. The building met all requirements for egress, water based suppression and structural fire protection. However, one inadequacy was found in the volume of the alarm / notification system in the shop area. While it is believed that the alarms would provide sufficient volume for the actual noise conditions in this area, the inadequacy could easily be remedied by installing an additional 2-3 alarm/notification devices. No other changes or improvements would be recommended at this time.

The performance based analysis will evaluate the building using an egress modeling program, a fire sprinkler modeling program, and against separate design fires using FDS modeling.

During the performance based analysis, it was determined that a fire in the second floor conference room would not inhibit occupants from having the required time exit while tenability conditions are met for two of the four exits from this floor. The analysis of the shop area pallet fire did show that visibility and temperature would become unacceptable at one exit before everyone exited the building, however the remaining six exits were tenable throughout the simulation. Wood pallets could be disallowed in the building, as they have been in other areas on site, to reduce any risk further. They could be replaced with metal pallets and avoid this hazard altogether. Overall the building was found to be in satisfactory condition and designed appropriately.

This report fulfills the completion requirement for the Fire Protection Engineering program at Cal Poly for a Master's of Science.

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1. Introduction:

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The results of the prescriptive based analysis of this building and any recommendations will then be presented.

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2. Building Overview

The Cold Machine Shop is located on the central coast of California on an industrial site. The building is approximately 133' x 203' giving a covered area of 27,000 ft^2. Figure 1 below shows an overview of the building from above. Figure 2 shows the view of the building looking south, showing the equipment rolling and sliding doors.

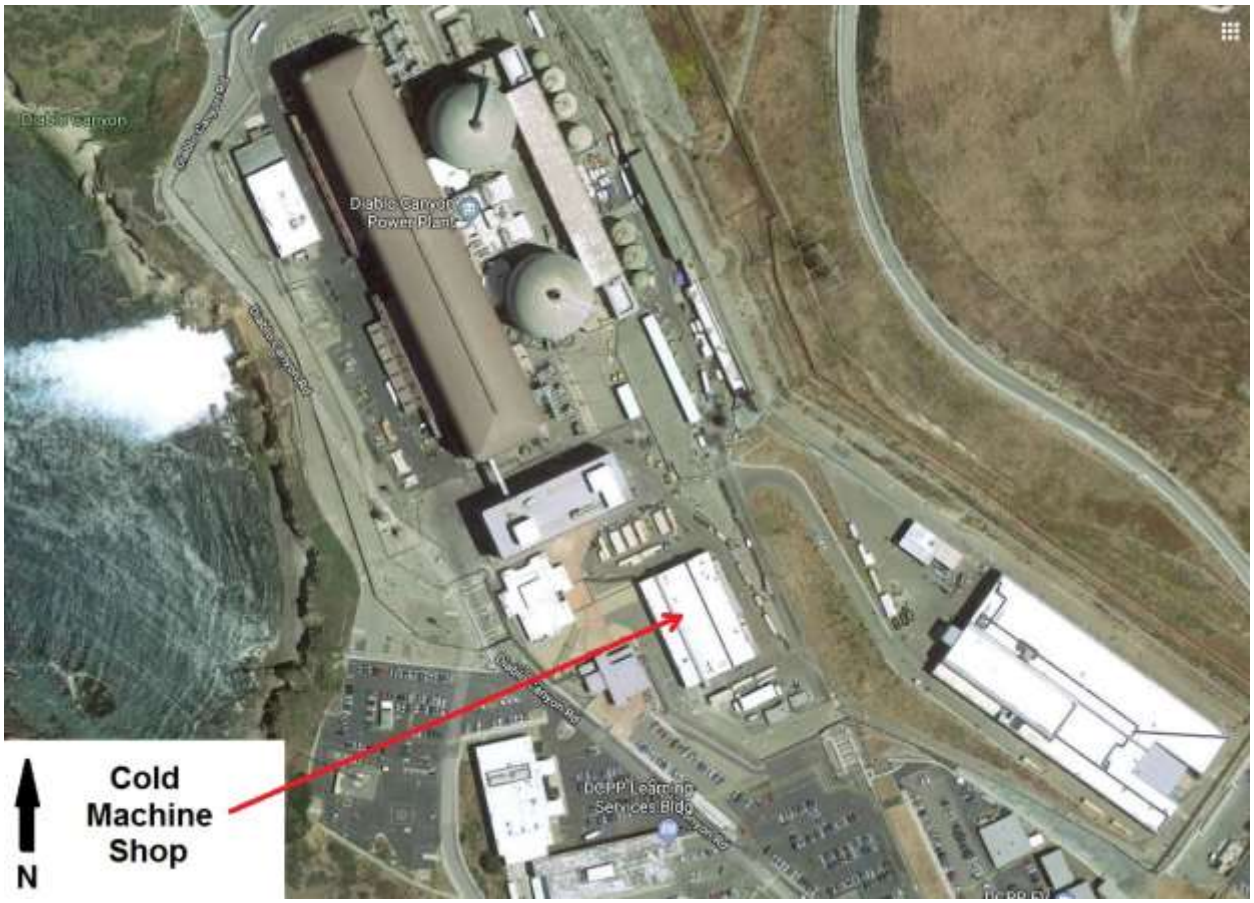


Figure 1: Geographic Location

Figure 2: North Side View

The building is comprised of shop work areas, storage areas and office areas. Shop areas are used for site employees to test, modify, and repair site materials and equipment to maintain the site. Office areas are the shop workers primary location when they are not in the shop or field working. These areas provide them somewhere to perform paperwork, computer based training, etc. Storage areas are used for staging tooling and materials to support work in the shop areas. The skeleton of the building is constructed of mostly steel beams, concrete walls, and sheet metal siding/roofing. The interior office areas are comprised of steel studs and drywall with minimal carpet. See Figures 3 and 7 below for floor layouts. See Figures 4, 5, 6, 8, 9, 10, 11, 12 and 13 for pictures. Picture locations are denoted by blue arrows and labeled on the layouts.

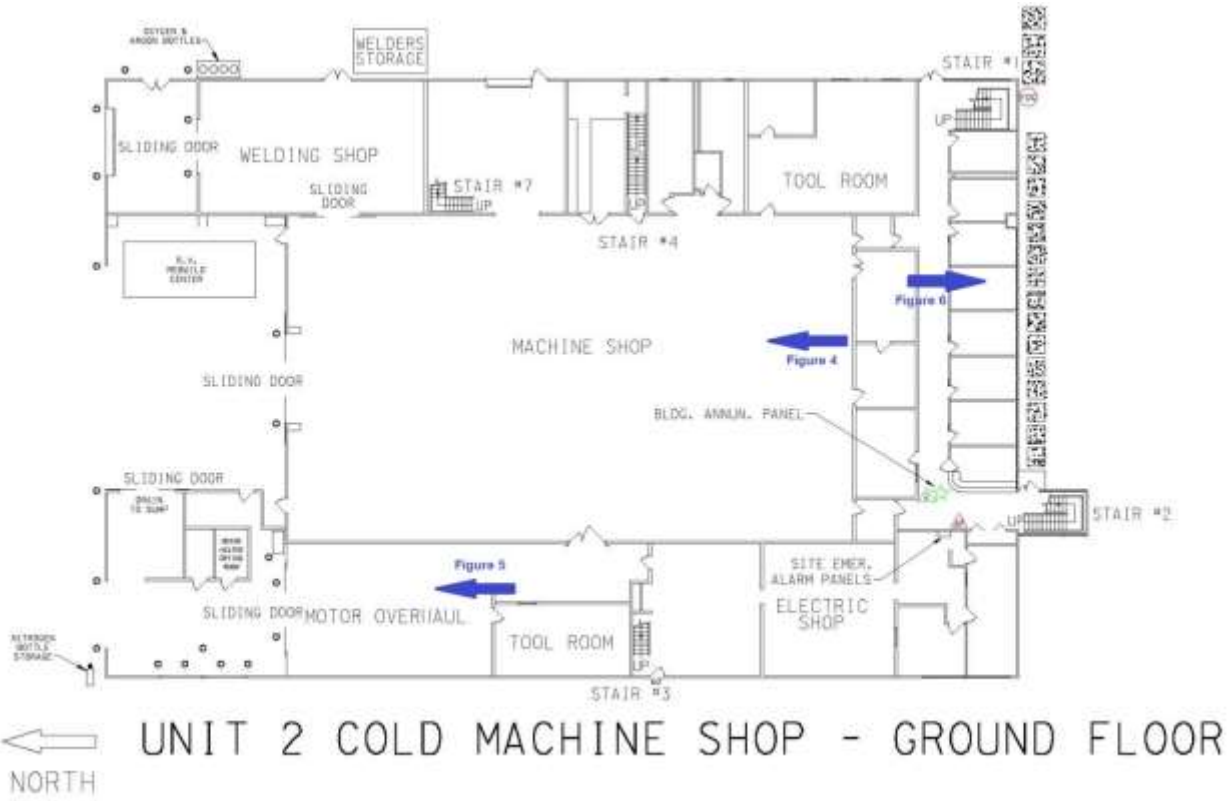


Figure 3: First Floor Layout

Figure 4: First Floor Maintenance Shop

Figure 5: First Floor Electrical Shop

Figure 6: First Floor Office

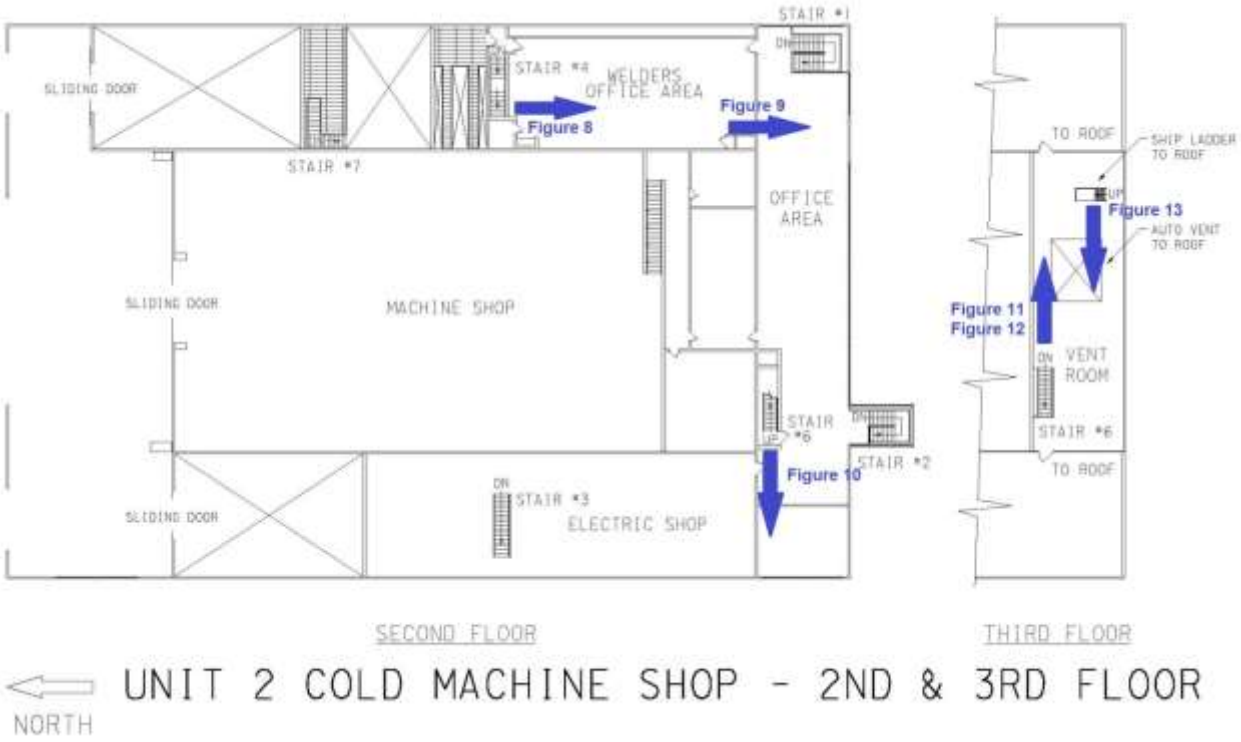


Figure 7: Second and Third Floor Layout

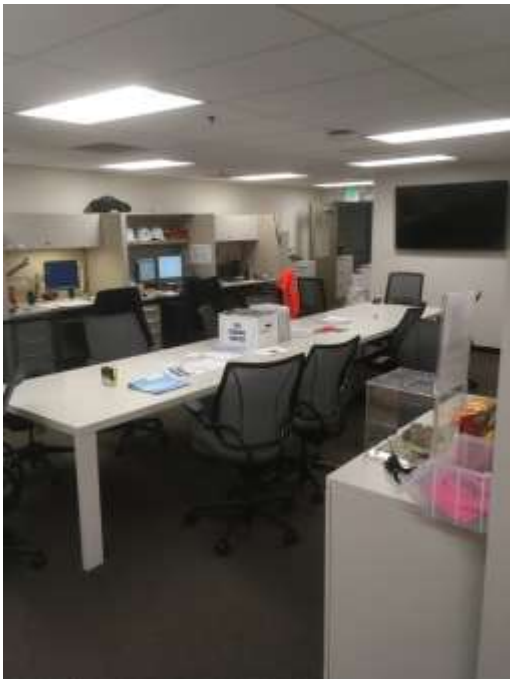


Figure 8: Second Floor Office Area

Figure 9: Second Floor Office Area

Figure 10: Second Floor Conference Room

Figure 11: Third Floor HVAC Room

Figure 12: Third Floor HVAC Room

Figure 13: Third Floor HVAC Room

With the basic layout and configuration laid out, the first aspect of the prescriptive based performance that will be analyzed egress requirements. This will take a look at occupant classification and loading, exit capacities, exit configurations and more.

3. Egress Analysis:

3.1. Occupancy Classification

Occupancy classification were analyzed and determined as shown in Figures 14 and 15 below (LSC Chapter 6 and Table 7.1.3.2). The first floor is primarily Industrial space with areas of Storage and Business as well. The second floor is almost entirely Business, with two small areas of storage. The third floor is strictly a Mechanical / HVAC room.

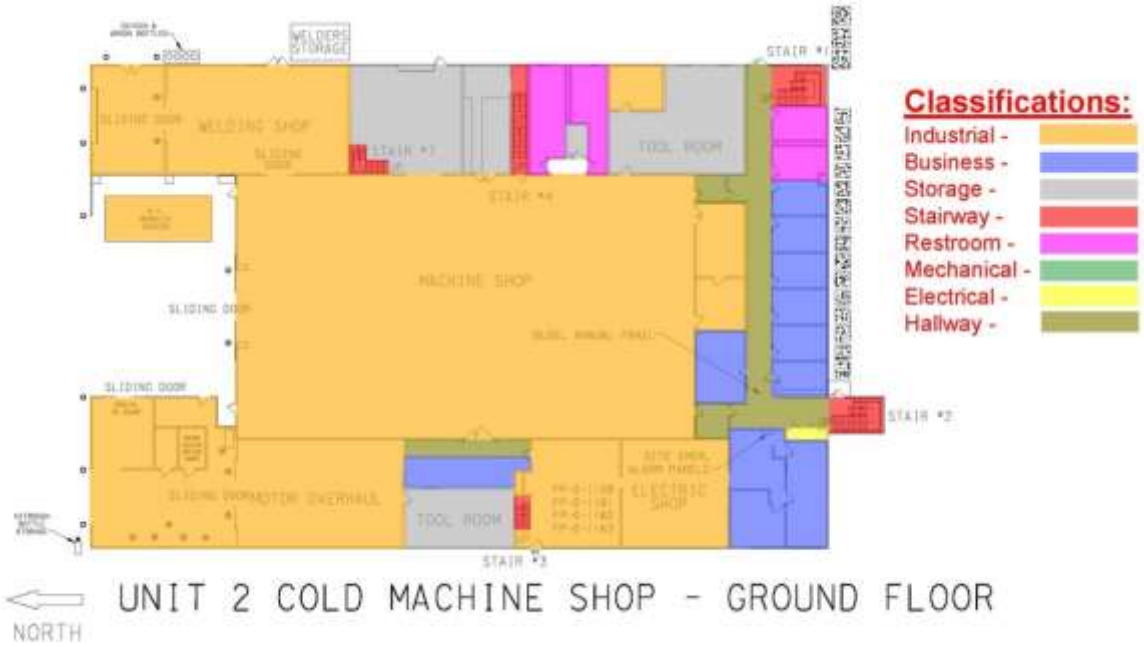


Figure 14: First Floor Occupancy Classifications

Figure 15: Second and Third Floor Occupancy Classifications

3.2. Occupancy Loads

Table 1 shows the determination of areas, occupancy classification, occupancy load factor, and calculated occupant load (LSC Chapter 6, Table 7.1.3.2 and Sections 12.1.7.1/2). The total building Occupant Load is 281 people (Floor 1 = 196 people + Floor 2 = 85 people + Floor 3 = 0 people).

Table 1: Occupant Loads by Room

Floor	Room #	Area		Category	Occupant Load Factor	Occupant Load	
1	101	1500	Weld Shop	Industrial Use: General and high hazard industrial	100	15	
		600	Weld Shop Expansion	Industrial Use: General and high hazard industrial	100	6	
	102	900	Receiving Area	Storage Use: In other than storage and mercantile occupancies	500	2	
	103	450	Rigging Loft	Storage Use: In other than storage and mercantile occupancies	500	1	
		150	Stairway #4	N/A	0	0	
	104	575	Restroom	N/A	0	0	
	105	50	Janitors Closet	Storage Use: In other than storage and mercantile occupancies	500	0	
	106	235	Restroom	N/A	0	0	
	107	1006	Mechanical Tool Room	Storage Use: In other than storage and mercantile occupancies	500	2	
	108	194.1	Tool Test Room	Industrial Use: General and high hazard industrial	100	2	
	109	130	Stairway #1	N/A	0	0	
	110	150	Restroom	N/A	0	0	
	111	150	Restroom	N/A	0	0	
	112	150	Foreman's Office	Business Use	100	2	
	113	150	Foreman's Office	Business Use	100	2	
	114	260	Lapping Room	Industrial Use: General and high hazard industrial	100	3	
	115	150	Foreman's Office	Business Use	100	2	
	116	195	Clean Room	Industrial Use: General and high hazard industrial	100	2	
	117	150	Foreman's Office	Business Use	100	2	
	118	247	Clerk's Office	Business Use	100	2	
	119	150	Foreman's Office	Business Use	100	2	
	121	120	Stairway #2	N/A	0	0	
	122	240	Clerk's Office	Business Use	100	2	
	123	110	Foreman's Office	Business Use	100	1	
	124	232	Clerk's Office	Business Use	100	2	
	125	145	Foreman's Office	Business Use	100	1	
	126	1620	Electrical Shop	Industrial Use: General and high hazard industrial	100	16	
	127	496	Electrical Tool Room	Storage Use: In other than storage and mercantile occupancies	500	1	
	127A	175	Hallway	N/A	0	0	
	127B	252	Issue Room	Business Use	100	3	
	128	2955	Motor Overhaul Shop	Industrial Use: General and high hazard industrial	100	30	
	130	9072	Machine Shop	Industrial Use: General and high hazard industrial	100	91	
	131	20	Communication Closet	N/A	0	0	
	134	77	Office	Business Use	100	1	
	135	77	Office	Business Use	100	1	
		306	Valve Clean Room	Industrial Use: General and high hazard industrial	100	3	Floor Total
		170	Valve Clean Room - Back Room	Industrial Use: General and high hazard industrial	100	2	196
2		300	Receiving Area	Storage Use: In other than storage and mercantile occupancies	500	1	
	201	1680	Office Area	Business Use	100	17	
	201A	56	Electrical Closet	N/A	0	0	
	201B	7	Communication Closet	N/A	0	0	
	202	100	Stairway #6	N/A	0	0	
	203	2100	Engineers Office Area	Business Use	100	21	
	204	704.4	Conference Room #2	Business Use	100	7	
	205	2820	Electrical Shop Storage	Business Use	100	28	
		1080	Storage Area (Offices)	Business Use	100	11	Floor Total
		450	Rigging Loft	Storage Use: In other than storage and mercantile occupancies	500	1	85
3	301	1512	Mechanical Room	N/A	500	0	Floor Total
					Building Total	281	0

3.3. Exit Capacities

The calculated exit capacities for each floor is shown in Table 2 below. For stairways with no doors, the stairway capacity was used for the door capacity of the stairwells. All three floors have adequate exit capacity. See below for calculations (LSC Section 7.3.3.1 and 7.3.3.2). Based on the Occupant Loads and requirements of the LSC each floor has the acceptable number of exits. Floors 1 and 2 have over the requirement. Based on the LSC, Floor 3 is not required to have two exits as it is a story used exclusively for mechanical equipment (LSC Section 7.12.2). Floors 1 and 2 do have the proper separation of exits as shown in Figures 16 and 17. Floor 1 has multiple examples of separation over 80ft. Floor 2 has 3 instances of exit separation greater than 58ft. These values are based on the building being sprinklered and abiding by the 1/3 rule (LSC Section 7.5.1.3.3). Table 2 below shows the measured values. This building does not employ any horizontal exits to move people to safe areas.

Table 2: Exit Capacities

	Occupant Load	Exit Capacity		Required Exits	Available Exits	Diagonal Distance	1/3 Diagonal Distance
		Stairways	Doors				
Floor 1	196		1620	2	9	241	80
Floor 2	85	705	745	2	4	172.5	58
Floor 3	0	120	180	1	1	75	25
Total	281						

$$Floor\ 2\ \boldsymbol{Stairway}\ Capacity = \frac{42\ inches}{.3\ {}^{inches}/_{person}} + \left(146.7 + \left(\frac{48\ inches - 44 inches}{.218}\right)\right) + \frac{42\ inches}{.3\ {}^{inches}/_{person}} + \frac{40\ inches}{.3\ {}^{inches}/_{person}} + \frac{38\ inches}{.3\ {}^{inches}/_{person}} = 705\ people$$

$$Floor\ 3\ \boldsymbol{Stairway}\ Capacity = \frac{36\ inches}{.3\ {}^{inches}/_{person}} = 120\ people$$

$$Floor\ 1\ \boldsymbol{Door}\ Capacity = = \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \frac{36\ inches}{.2\ {}^{inches}/_{person}} = 1620\ people$$

$$Floor\ 2\ \boldsymbol{Door}\ Capacity = = \frac{36\ inches}{.2\ {}^{inches}/_{person}} + \left(146.7 + \left(\frac{48\ inches - 44 inches}{.218}\right)\right) + \frac{42\ inches}{.3\ {}^{inches}/_{person}} + \frac{40\ inches}{.3\ {}^{inches}/_{person}} + \frac{38\ inches}{.3\ {}^{inches}/_{person}} = 745\ people$$

$$Floor\ 3\ \boldsymbol{Door}\ Capacity = \frac{36\ inches}{.2\ {}^{inches}/_{person}} = 180\ people$$

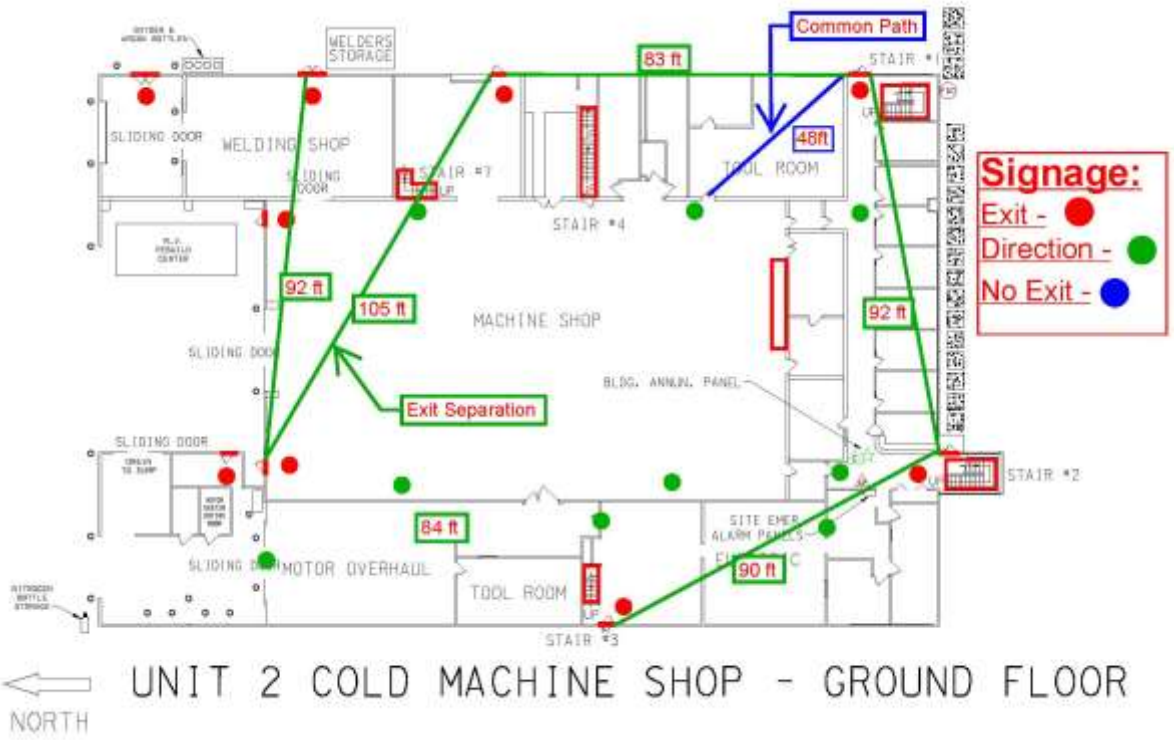


Figure 16: First Floor Signage, Common Path, and Exit Separation

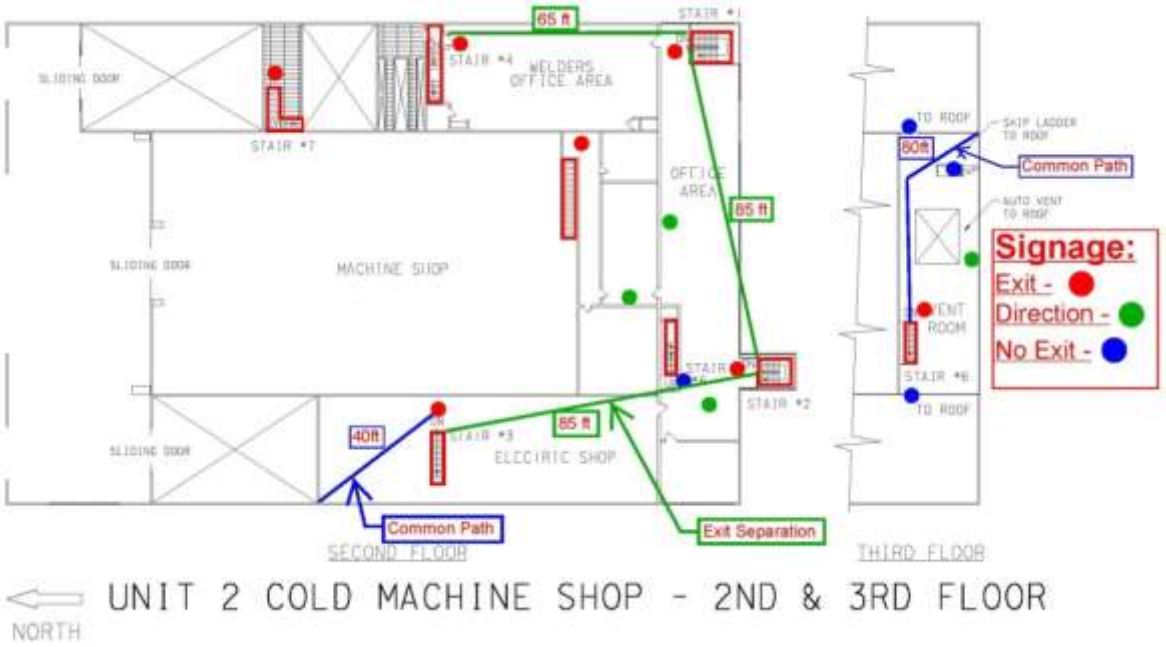


Figure 17: Second and Third Floor Signage, Common Path, and Exit Separation

3.4. Exit Pathways

Given the fact that the building is sprinklered, the travel distance is 300ft for Business classification, 250ft for Industrial - General Classification, and 400ft for Storage - Ordinary Hazard Classification (LSC Table A.7.6). Given the diagonal distances for each floor are less than those values, there is no issue with travel distance. As measured, none of the travel distances to an exit on any floor even exceed 150ft, and are not even close to 250ft (The most restrictive of the three classifications), thus meeting the LSC requirements.

The Common Path Limits for Business, Industrial, and Storage Classifications are all 100ft (LSC Table A.7.6). The required Common Path does not seem to be an issue other than on the Floor 1. The longest Common Path measured was 48ft which is shown on Figure 16. Floor 2 has a maximum common Path of 40ft. With only one exit on Floor 3, the common path is 80ft for this floor. Floor 2 and 3 examples are shown on Figure 17.

The Dead End Limits for Business, Industrial, and Storage Classifications are 50ft, 50ft, and 100ft, respectively (LSC Table A.7.6).During evaluation of the building, no Dead Ends were identified.

3.5. Fire Resistance and Finishes

The required fire resistance rating for the stairway enclosures would be 2hr fire rating for the walls/partitions and 1-1/2hr for the doors (LSC Table 8.3.4.2). The required fire resistance rating for the exit corridors would be 1hr fire rating for the walls/partitions and 1/3hr for the doors (LSC Table 8.3.4.2).

The Interior Finish Classification Limitations for the building could be A or B. To save costs and effort Class B would be the prudent class to use. (LSC Table A.10.2.2) Based on the assumption that Class B is the prescribed or used class, the requirements for interior wall and ceiling finish materials, except as shown in table A.10.2, would be tested per ASTM E 84 or ANSI/UL 723, accepted per Class B, in accordance with 10.2.3.4 (2), applied as required by section 10.2.3. (LSC Table A.10.2)

3.6. Signage:

Exit signage placement should be placed in accordance with the LSC (LSC Section 7.10). Specific considerations include placing signage every 100ft minimum (LSC Section 7.10.1.5.2), marking dead ends or non-exit routes that could be misconstrued for exit routes (LSC 7.10.8.3), directing people when the direction to the next exit may be unclear (LSC 7.10.2.1) and marking exits/stairwells. (LSC 7.10.1.2.1) See Figures 16 and 17 mark-ups for specific locations.

3.7. Occupant Characteristics

A number of factors of the occupancy of this building make it conducive to short evacuation times. Most people in this building will be familiar with the layout and configuration of the building. Employees work in the building daily and will be quite familiar with the layout. Additionally, the building will generally not be populated at night and will not have people sleeping there so all people present at the start of a fire will be awake and "alert". Employees would have a good sensibility, reactivity, mobility, and susceptibility. (LSC Section 5.4.5.2) This can be derived from their age and professionalism. They would also be alert, focused, capable, and familiar with the building leading to short times. However, some employees may be unresponsive due to lack of concern for the alarm, uncommitted due to lack of concern for the alarm, and not have a designated role and poor affiliation due to age and desire not to stand out. Table 3 below shows a simple calculation of egress time using the SFPE formula. Using that formula, the egress time for the building was found to be 48 seconds. Later in this report a simulation program will be used that uses the actual building configuration to calculate egress time.

SFPE:
Maximum specific flow = 1.3 P/s/m (doorway)

$$t(min) = {Occupant\ Load}/{1.3 \times w_e}$$

Table 3: Egress Times

	Occupant Load	Total Effective Door Widths (w_e) (ft)	Total Effective Door Widths (w_e) (m)	t(s)	t(min)
Floor 1	196	216	5.5	27.5	0.5
Floor 2	85	144	3.7	17.9	0.3
Floor 3	0	24	0.6	0.0	0.0
Total	281			Total	0.8

Assumptions related to these calculations would be as follows: All people start evacuation at same instant; All people able bodied and have no interruptions in evacuation; All floors are exactly the same; both stairwells are available; no issues or limiting factors on the first floor; assumed ALL floor space in calculation of occupant load with no subtractions.

Some limitations to the above calculations for exit time would include the assumptions above tending to optimize egress times and therefore will tend to underestimate actual egress times, and the Occupant Loads will vary widely and often will be less than prescribed as many employees spend their day in the field performing work, thus their office/work space will sit open during certain times of the day. Additionally, this method fails to account for any restrictions or issues within each floor. It assumes that the doors/stairwells are the limiting factor in every case.

3.8. Summary:

After analyzing the building based upon NFPA 101: Life Safety Code, the Cold Machine Shop meets all aspects of the code. It was found to have proper separation of exits, exit capacity, exit pathway characteristics and signage. No issues were found during the egress analysis.

The next section of the analysis will look at system that notifies the occupants that they should exit a building during a fire, the alarm and detection system. This analysis will look at the devices and their controllers, system layout, system operation, system testing/maintenance and a warning additional system that is installed in the building.

4. Alarm / Detection Analysis:

4.1. Detection System Overview:

The building is completely sprinklered with an upper and lower system sprinkler system. Upright and pendent sprinklers of varying size are utilized throughout. The building is also covered by standpipe/hose system. These are used as the detection devices for actuation of the fire alarm. The building fire annunciator panel and fire alarm control panels are located in the southwest corner of the building on the opposite side of the wall from each other. These panels communicate with the panels / alarm systems of the other buildings on site and would actuate an alarm in those buildings as well if the fire system were to actuate in the Cold Machine Shop. Likewise the alarms would actuate in the Cold Machine Shop if a system were actuated in another building on site.

4.1.1. Fire Alarm Control Panels

4.1.1.1. The annunciator panel (DC-0-18-I-PNL-DGP05) is a Johnson Controls model IFC-3030 Intelligent Addressable Fire Alarm System. Figure 18 below shows the location of the panel in the southwest corner of the building. See Appendix A for detailed panel information.

Figure 18: Annunciator Panel

4.1.1.2. The Fire Alarm Control Panels (DC-0-97-E-PNL-EACC6/6A) are a Federal Signal Corp. model 300SSC Supervised SelecTone Command - Series B Figure 19 below shows the location of the panel in the southwest corner of the building. See Appendix A for detailed panel information.

Figure 19: Fire Alarm Control Panels

4.2. Detection Devices:

The primary detection device used in this building is the sprinklers. As stated before the building is completely sprinklered. The hose reels are also used as a detection device. If actuated they trip a flow switch that would actuate an alarm. Figures 20 and 21 show the firewater main coming into the building and show the main splitting into the three system risers. The blue arrows point to the flow switches that act as the actuation element for the panels when the sprinklers or hose reel system actuates. There are no smoke detectors installed throughout the building. However, there are ones installed in the third floor mechanical room where the supply and exhaust fans are housed. Controls for the fans are at this location and at the Motor Control Center of the second-floor electric shop. Photoelectric smoke detectors are used to shut down the Supply and Return Air Systems. Detectors are resettable at the temperature control panels that are on the exterior of the main duct. See Appendix B for sprinkler / detector information.

4.2.1. Detection Device Components:

- 1/2" Reliable Upright rated at 175°F / 155°F - Standard Response
- 1/2" Reliable Pendent rated at 175°F / 155°F - Standard Response
- 17/32" Reliable Upright rated at 175°F / 155°F - Standard Response
- Smoke detectors - Could not locate any information on the smoke detectors used in the HVAC ducting in the Mechanical room.

4.2.1.1. Riser Components:

- 6" Clow Gate Valve
- 4" Reliable Check/ Alarm Valve
- (2) 4" Kennedy Gate Valve
- 2.5'' Kennedy Gate Valve
- V52-D Potter Electric Flow Switches
- OSYS-4 Potter Electric Tamper Switches
- HLPS Potter Electric Alarm Pressure Switch
- Schedule 40 steel pipe

Figure 20: Firewater Riser

Figure 21: Firewater Riser

4.3. Detection Device Layout:

As the sprinklers are used as the main detection devices, Section 17.6.3 of NFPA 72 (2016) defines the spacing requirements. Section 17.6.3.1.1 states that detectors shall not exceed their listed spacing and shall be within half that distance from walls and no point shall be more than 0.7 times that spacing from a detector. This is similar to smoke detectors without the 30' nominal spacing requirement. Figure 22 shows the installed layout of the lower sprinkler system and Figure 23 shows the layout of the upper sprinkler system. The yellow represents the lower sprinkler system and the orange represents the upper sprinkler system. Blue and green represent portions of the hose reel systems, while purple represents the Fire Department Connection.

The cold machine shop sprinklers were designed to an Ordinary Hazard, Group II with a density of 0.19gpm/ft^2 and an application area of 1500ft^2. Figure 22 shows the layout of the lower sprinkler system and Figure 23 shows the layout of the upper system. Based on FIGURE 11.2.3.1.1 Density/Area Curves of NFPA 13 (2013) these are not the current appropriate values for design for this building, however they were acceptable at time of design. Looking at the sprinkler layout and based on analysis performed in FPE 523 it would appear the sprinklers meet any and all spacing requirements of NFPA 72 and NFPA 13.

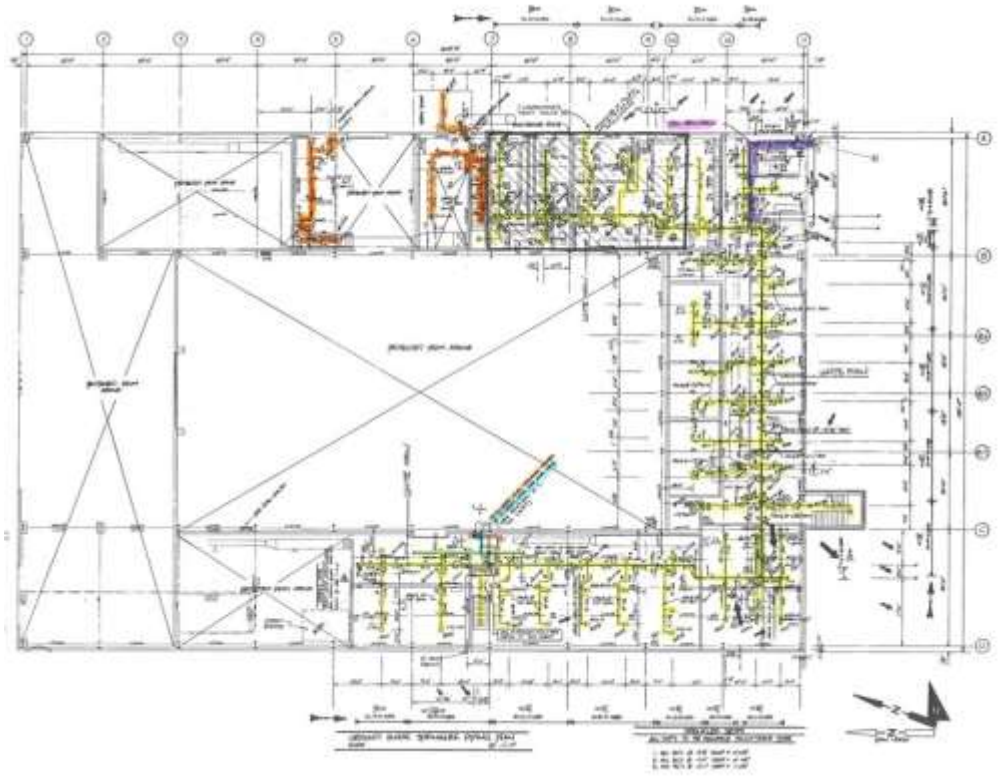


Figure 22: Lower Sprinkler System Layout

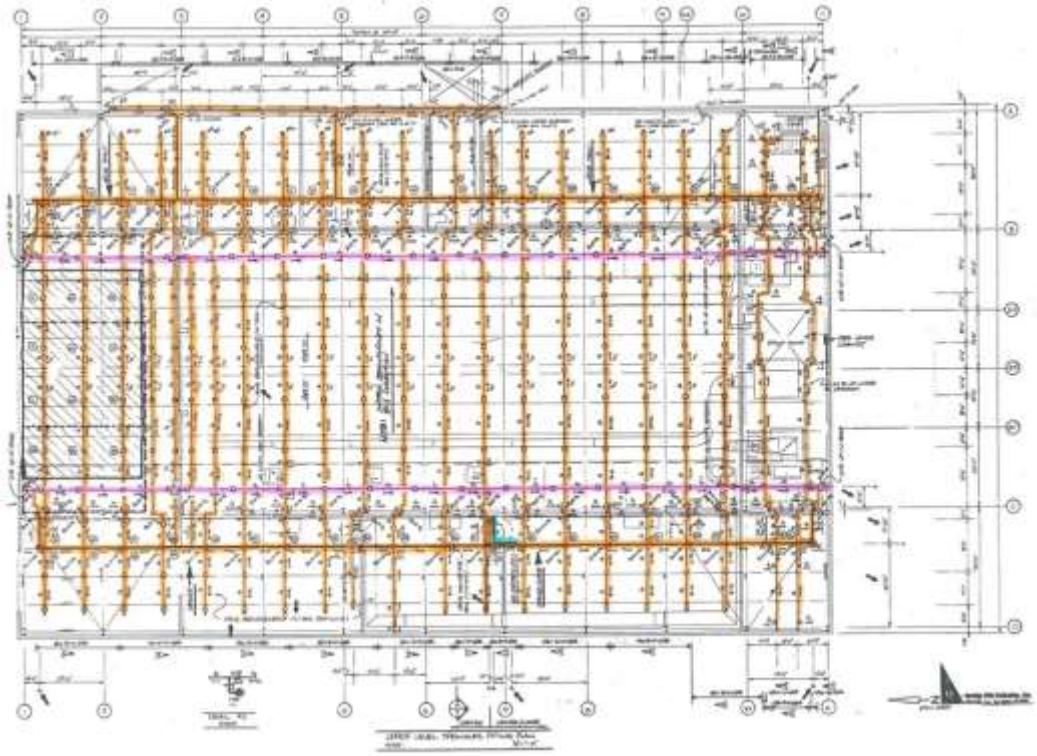


Figure 23: Upper Sprinkler System Layout

4.4. Detection Device Activation:

The activation times and characteristics were calculated for three areas using the DETACT model. The three areas chosen to look at were the office areas, the shop area, and the third floor mechanical room. These three areas were shown for their distinct characteristics. The shop area has a 30ft ceiling, while the office area and mechanical room have 8.5ft ceilings.

4.4.1. Office Area

In the office area a medium growth rate was chosen as it falls in line with industry experiments (Design Fires for Means of Egress in Office Buildings based on Full-scale Fire Experiments). No cap was set on HRR.

Sprinkler Assumptions:
Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)
Ceiling Height = 8.5ft / 2.6m
Actuation Temperature = 155°F / 68°C (Appendix C)
RTI = 80 m-s1/2 - Ordinary Response (NFPA 13 – 2010 Section 3.6.1)

Table 4: Office Area DETACT Model Inputs

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	2.6	m	R/H	0.962
Radial distance (R)	2.5	m	dT(cj)/dT(pl)	0.308
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.207
Actuation temperature (Td)	68	C	Rep. t2 coeff.	k
Response time index (RTI)	80	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.012	kW/s^n	Fast	0.047
Time step (dt)	2	s	Ultrafast	0.400

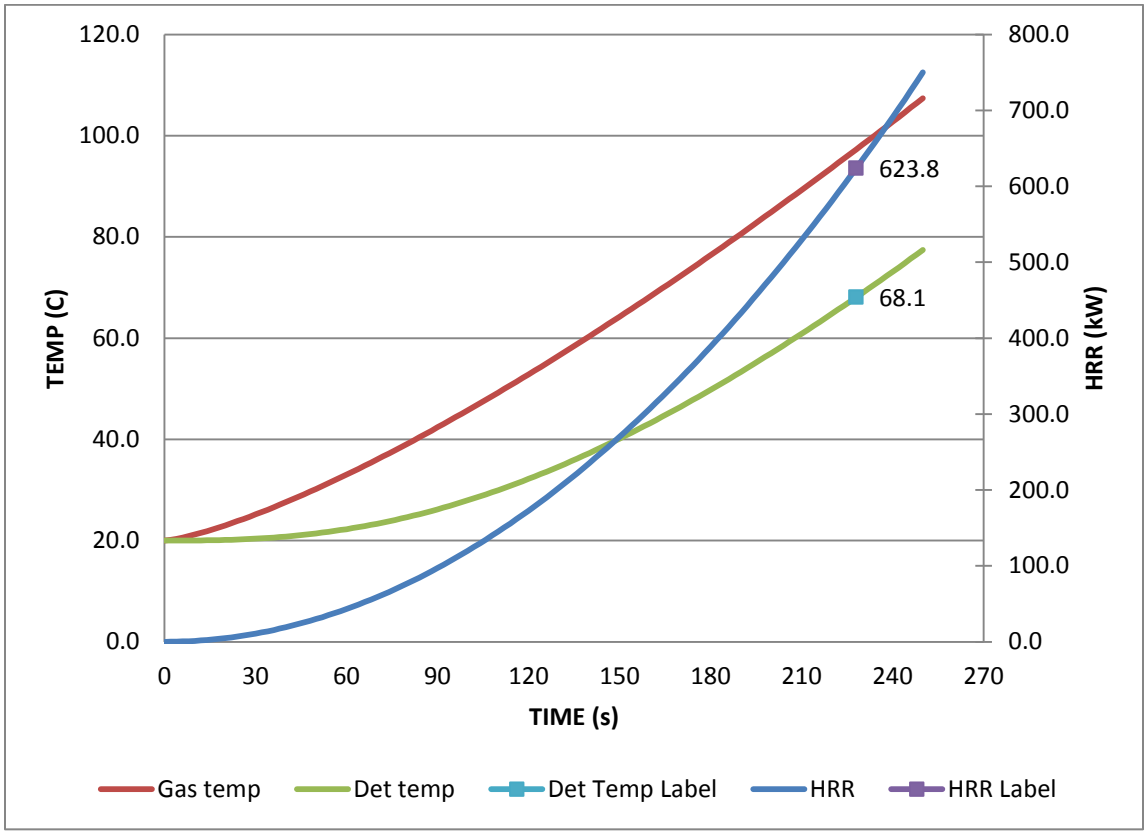


Figure 24: Office Area DETACT Model

Table 5: Office Area DETACT Model @ Activation Time

Calculation time (s)	HRR	Gas temp	Gas velocity	Det temp	dT/dt
228	623.8	97.3	1.28	68.09	0.4136

4.4.2. Shop Area

The shop area does not have a lot of fuel to speak of. Most of the area is made of concrete and masonry block. Most materials within the area are metal or metal machining equipment, however it could have pallets inside, so a medium fire growth rate was chosen. A peak HRR was of around 9000kW was used based on a pallet fire.

Sprinkler Assumptions:
Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)
Ceiling Height = 34ft / 10.36m
Actuation Temperature = 175°F / 79°C (Appendix C)
RTI = 80+ m-s1/2 - Ordinary Response (NFPA 13 – 2010 Section 3.6.1)

Table 6: Shop Area DETACT Model Inputs

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	10.36	m	R/H	0.962
Radial distance (R)	2.5	m	dT(cj)/dT(pl)	0.308
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.207
Actuation temperature (Td)	79	C	Rep. t2 coeff.	k
Response time index (RTI)	80	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.012	kW/s^n	Fast	0.047
Time step (dt)	2	s	Ultrafast	0.400

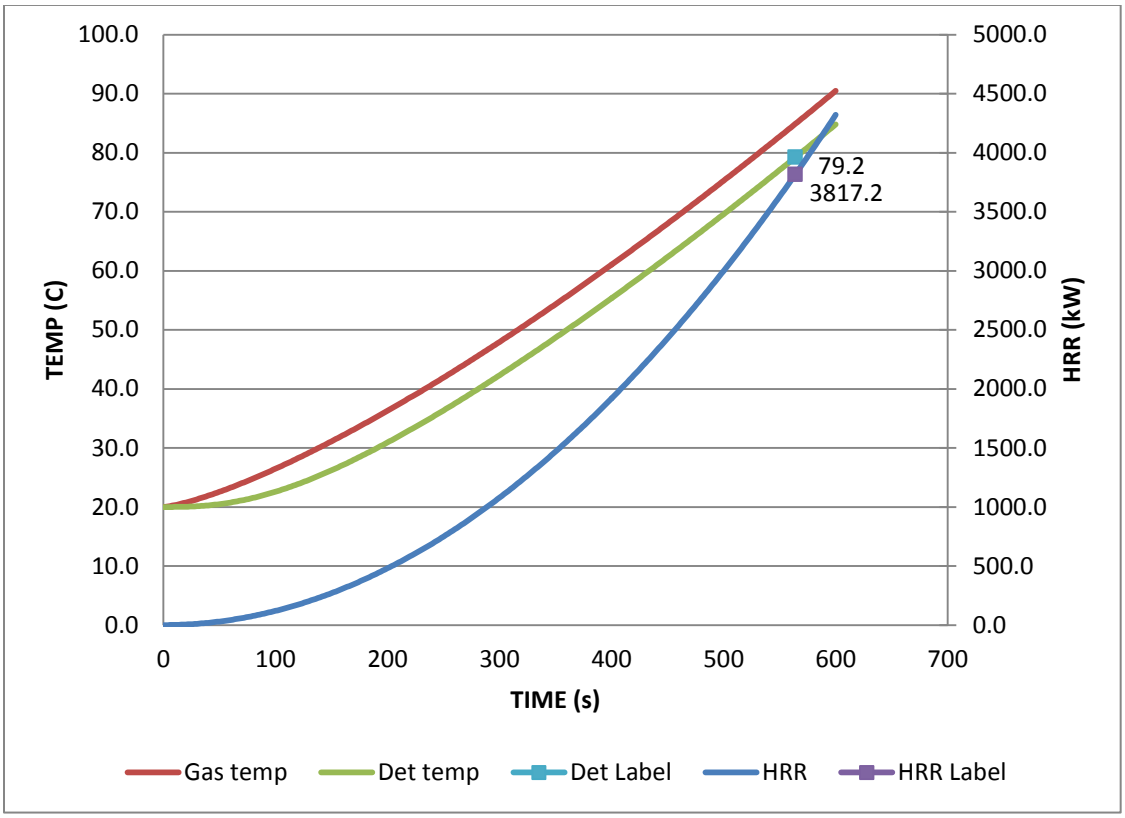


Figure 25: Shop Area DETACT Model

Table 7: Shop Area DETACT Model at Activation Time

Calculation time (s)	HRR	Gas temp	Gas velocity	Det temp	dT/dt
564	3817.2	84.9	4.69	79.22	0.1535

4.4.3. Fan Area

The fan area does not have any fuel to speak of in the area. A slow fire growth coefficient was chosen because of this. It is assumed that the fire keeps growing with no cap on HRR.

Sprinkler Assumptions:
Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)
Ceiling Height = 8.5ft / 2.6m (Fan Area)
Actuation Temperature = 68°F + 13°F = 71°F / 20°C + 7.2°C = 27.2°C (NFPA 72 – 2010 Table B.4.7.5.3)
RTI = 2 m-s1/2 (Detector inaccurate based on heat so low RTI)

Table 8: HVAC Area DETACT Model Inputs

INPUT PARAMETERS			CALC. PARAMETERS	
Ceiling height (H)	3.6	m	R/H	0.898
Radial distance (R)	3.2	m	dT(cj)/dT(pl)	0.322
Ambient temperature (To)	20	C	u(cj)/u(pl)	0.219
Actuation temperature (Td)	27.2	C	Rep. t2 coeff.	k
Response time index (RTI)	2	(m-s)1/2	Slow	0.003
Fire growth power (n)	2	-	Medium	0.012
Fire growth coefficient (k)	0.003	kW/s^n	Fast	0.047
Time step (dt)	2	s	Ultrafast	0.400

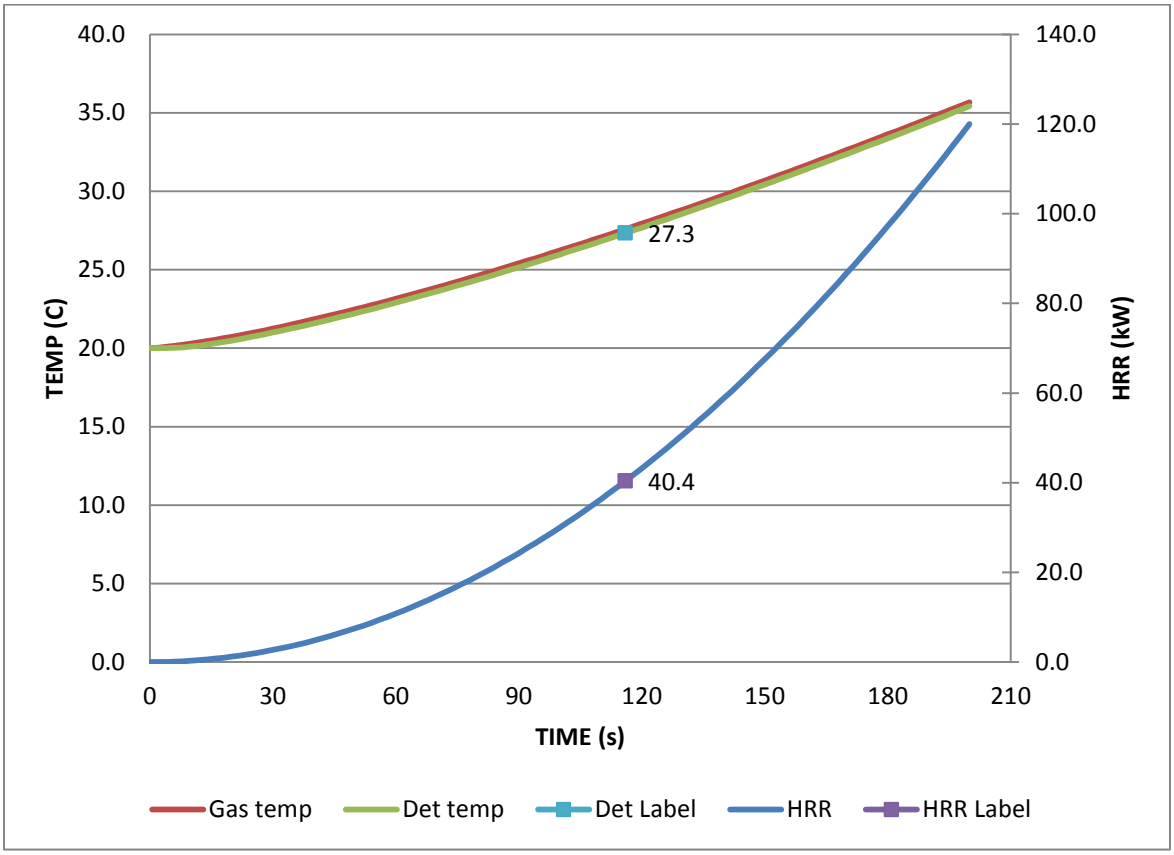


Figure 26: HVAC Area DETACT Model

Table 9: HVAC Area DETACT Model @ Activation Time

Calculation time (s)	HRR	Gas temp	Gas velocity	Det temp	dT/dt
116	40.4	27.6	0.49	27.33	0.0874

4.5. Fire Alarm System:

The system installed in the Cold Machine Shop is at its core a Protected Premises System. The main purpose is to active the audible alarms to notify the occupants that they must evacuate. The system includes alarm, supervisory and trouble signals. The alarm signal encompasses the audible alarms activated by the activation of the flow switches for the sprinklers / hose reels as well as the duct smoke detectors. The supervisory signals are the actions signals to the onsite Fire Department to take action based on a fire event in the Cold Machine Shop. These come from the tamper switches on the riser manifold. The trouble signal could include a signal from the tamper switches or loss of primary or secondary power. The Cold Machine Shop's system also includes a Proprietary System component. All buildings onsite are part of an interconnected system that is monitored by the main control room for the site. The system also includes the automated actions of shutting down the supply fans if the smoke detectors on the ducts detect smoke. The requirements for the system setup and signals are located in NFPA 72, Ch. 23 – Protected Premises Fire Alarm Systems, Ch. 26 – Supervising Station Alarm Systems and Annex C – System Performance and Design Guide.

4.5.1. Alarm Notification Devices:

4.5.1.1. Selectone Site Emergency/Fire Alarm Horn (Appendix D for additional Data)

Federal Selectone Audible Signaling Device
Model 50GC, with 300CKS connector kit for indoor use, ceiling flush mounting, 24VDC, color beige with FG grill and FBL box. For use with 300SSC Selectone Command Module
Decibel Output = 88 at 10 Feet / 98 at 1 Meter

4.5.1.2. Code Call Bell - Chime type

Federal single-stroke chime, model 101, rated 120VAC, 60Hz
Decibel Output = 98 at 10 Feet / 108 at 1 Meter

4.5.1.3. Code Call Bell - Vibratone Type (Appendix D for additional Data)

Federal Vibratone bell, single stroke mechanism model 700, 120VAC, 60Hz. Four inch gong assembly model A4 and knockout box model NB, for indoor use, color grey.
Decibel Output = 98 at 10 Feet / 108 at 1 Meter

See Figure 27, 28, and 29 for examples of each notification device installed in the building. See Appendix C for location.

Figure 27: Alarm Horn and Code Call Bell (Vibratone Type)

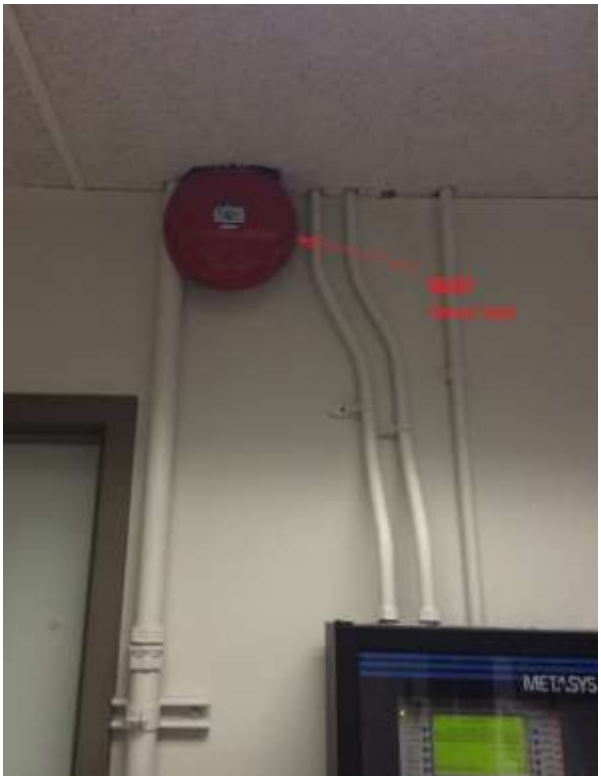


Figure 28: Code Call Bell (Chime Type)

Figure 29: Alarm Horn and Code Call Bell (Vibratone Type)

4.5.2. Alarm Location, Spacing and Placement

NFPA 72, Section 18 prescribes the requirements for audible alarms. The maximum dBA of the ambient and alarm shall be no greater than 110 dBA. Per 18.4.3 the alarm shall be at least 15 dB above ambient or 5dB above maximum. Per 18.4.8.1, if ceiling heights allow, and unless otherwise permitted by 18.4.8.2 through 18.4.8.5, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in. (2.29 m) and below the finished ceilings at distances of not less than 6 in. (150 mm). 18.4.8.2 Ceiling-mounted or recessed. Per 18.4.8.5, mounting heights other than required by 18.4.8.1 and 18.4.8.2 shall be permitted, provided that the sound pressure level requirements of 18.4.3 for public mode are met.

Based on an alarm dB of 88dB at 10ft, the alarm would produce 82dB at 20ft, 76dB at 40ft, 70dB at 80ft, and 64dB at 160ft.

The Cold Machine Shop is generally used as office / class room setting (Similar to an Education occupancy = 45dBA (NFPA 72, Table A.18.4.3)) with some louder industrial type work in the shop area (Similar to an industrial occupancy = 80dBA (NFPA 72, Table A.18.4.3)), however the majority of the time the building is fairly quiet. No place in the building is more than 160ft from an alarm, thus no point would receive anything less than 64dB from the alarm. This would meet the office / classroom requirement of 60dB (45dBA + 15dB). The industrial areas of the shop are no more than 60ft from an alarm. Assuming the industrial ambient to be a maximum in the shop, the requirement would be 80dBA + 5dBA = 85dB. It does not appear that the requirement would be met as the alarm dB at a

conservative distance of 80ft would be 70dB. While this does not meet the requirement laid out in NFPA 72, I believe that the 80dBA to be a gross overestimation based on my experience in the shop. I have never been in the shop where I have had to raise my voice in the slightest to communicate with someone standing next to me.

Overall the alarms are installed properly throughout the office areas, except in the shop area, where it appears the area is one or two alarms short of complying with the code.

Table 10: Alarm Performance: Required vs. Provided

Area	Ambient dBA	Required dB	Distance from Alarm (ft)	Alarm Volume (dB)
Office	45	60	160	64
Industrial	80	85	60	70

See Appendix C for alarm locations.

4.6. Mass Notification System (Site PA System):

The site is equipped with a PA system to make announcements. While not directly controlled or connected to the fire alarm / notification system, this would be used to communicate information to employees' onsite in the event of a fire or any other emergency. The PA system is located in every area of every building onsite and designed to be heard by everyone no matter the location or noise level of that location. Announcements are made from the main control room of the site which in almost any circumstance would be isolated from any fire onsite and would definitely be isolated from a fire in the Cold Machine Shop. See Figures 30 and 31 below for pictures of this additional system.

Figure 30: Site PA System

Figure 31: Site PA Alarm

4.7. Fire Alarm System Secondary Power Supply:

Based on Section 10.6.7 "Secondary Power Supply" of NFPA 72 (2016) the secondary power for the fire alarm system would be required to provide stand by power for 24 hours and alarming power for 15 minutes. Based on a calculation of the load requirements for this system (See Appendix F), to provide the requirements of NFPA 72, the annunciator panel would need a battery of 19.1 Ah. The annunciator panel is equipped with a 26 Ah capacity so it easily meets the requirements. The FACP would require a battery of 6.9Ah and contains an 8Ah battery. This would also meet the requirements of NFPA 72. The calculations for these values are shown in Table 11 for the Annunciator Panel and Table 12 for the FACP.

Table 11: Annunciator Panel Battery Load Calculation

Johnson Controls - IFC-3030 Intelligent Addressable Fire Alarm System

Device	Quantity	Current (Amps)		Total Current (Amps)	
		Standby	Alarm	Standby	Alarm
CPU-3030D - IFC-3030 Primary Display	1	0.2000	0.1000	0.2000	0.1000
NCM-W - Network Communications Module, Wire	1	0.1100	0.1100	0.1100	0.1100
LCM-320 - Loop Control Module	1	0.1300	0.1300	0.1300	0.1300
LEM-320 - Loop Expander Module	1	0.1000	0.1000	0.1000	0.1000
RPT-W - Repeater Board, Wire Connection	1	0.0170	0.0000	0.0170	0.0000
XP10-M - Ten-input monitor module	1	0.0004	0.0055	0.0004	0.0055
XP6-R - Six-Supervised Control Module	1	0.0002	0.0032	0.0002	0.0032
AMPS-24 - Power Supply	1	0.1040	0.0000	0.1040	0.0000
			Total (Amps)	0.6615	0.4487
			Duration (hr)	24.0000	0.0833
			Required Amp-hr (Ah)	15.8760	0.0374
			Margin of 20% (Ah)	3.1752	0.0075
			Total Batter Demand (Ah)	19.096	
			Batter Capacity (Ah)	26	

Table 12: FACP Battery Load Calculation

SelecTone® Supervised Command Unit - Model 300SSC

Device	Quantity	Current (Amps)		Total Current (Amps)	
		Standby	Alarm	Standby	Alarm
SelecTone® Audible Signaling Device - Model 50GC	9	0.0250	0.0900	0.2250	0.8100
Vibratone® Bells	9	0.0000	0.0800	0.0000	0.7200
3.9k End of Line Resistor	1	0.0100	0.0100	0.0100	0.0100
			Total (Amps)	0.2350	1.5400
			Duration (hr)	24.0000	0.0833
			Required Amp-hr (Ah)	5.6400	0.1283
			Margin of 20% (Ah)	1.1280	0.0257
			Total Batter Demand (Ah)	6.922	
			Batter Capacity (Ah)	8Ah	

4.8. Inspection, Testing and Maintenance Requirements:

NFPA 72, Chapter 14 prescribes the inspection, testing and maintenance requirements for a fire alarm system. Table 14.3.1 specifically calls out "Visual Inspections" and 14.4.3.2 calls out "Testing". Regarding the Cold Machine Shop, some inspections are performed by the Fire Department Staff onsite. However the majority of inspection and testing is contracted out to

vendor Cosco. Maintenance is performed on the system by both the onsite maintenance personnel and Vendor Cosco. The following is a list of inspections/testing performed by Cosco as part of an annual inspection:

4.8.1. Field Devices Tested:

- Duct Detectors - Photoelectric (4): Found functional and satisfactory
- Water Flow Switches - Paddle (2): Found functional and satisfactory
- Tamper Switches (3)

4.8.2. Signaling Devices:

- 1 Bell: Found functional

4.8.3. Supervisory Functions:

- Main Power: Found satisfactory
- Backup Power: Found satisfactory
- Trouble Silence Switch: Found satisfactory
- Trouble Audible: Found satisfactory
- Trouble Visual: Found satisfactory
- Ground Fault: Found satisfactory
- Disconnect Switches: Found satisfactory

4.8.4. Panel Operations:

- Initiating Circuits: Found satisfactory
- Signal Circuits: Found satisfactory
- Alarm Silence Switch: Found satisfactory
- Alarm Reset Switch: Found satisfactory
- Lamp Test Switch: Found satisfactory
- All Lamps/LED's: Found satisfactory

4.8.5. Panel Operations:

- Central Station: Found satisfactory

4.9. Summary:

Upon analysis of the building based on NFPA 72, 72A, 72D and 13, the Cold Machine Shop was found to meet most aspects of the code, with the exception of the required notification volume in the shop area. The detection system, devices, layout and testing are all appropriate for the building. The notification system devices themselves are appropriate, however, the layout and number of devices could be improved to ensure the volume requirements meet the code.

The next section of the analysis will look at the system that is used for detection, the water based suppression system. This analysis will look at the water supply, riser, sprinklers, hose reel systems, system capabilities and demand, as well as, system testing and maintenance.

5. Water Based Suppression Systems:

The building is completely sprinklered with an upper and lower system sprinkler system. Upright and pendent sprinklers of varying size are utilized throughout. The building is also covered by standpipe/hose system. An isometric view of the system headers/primary piping is shown below in Figure 32. The yellow represents the lower sprinkler system and the orange represents the upper sprinkler system. Blue and green represent portions of the hose reel systems, while purple represents the Fire Department Connection. See Appendix E for detailed sprinkler layouts.

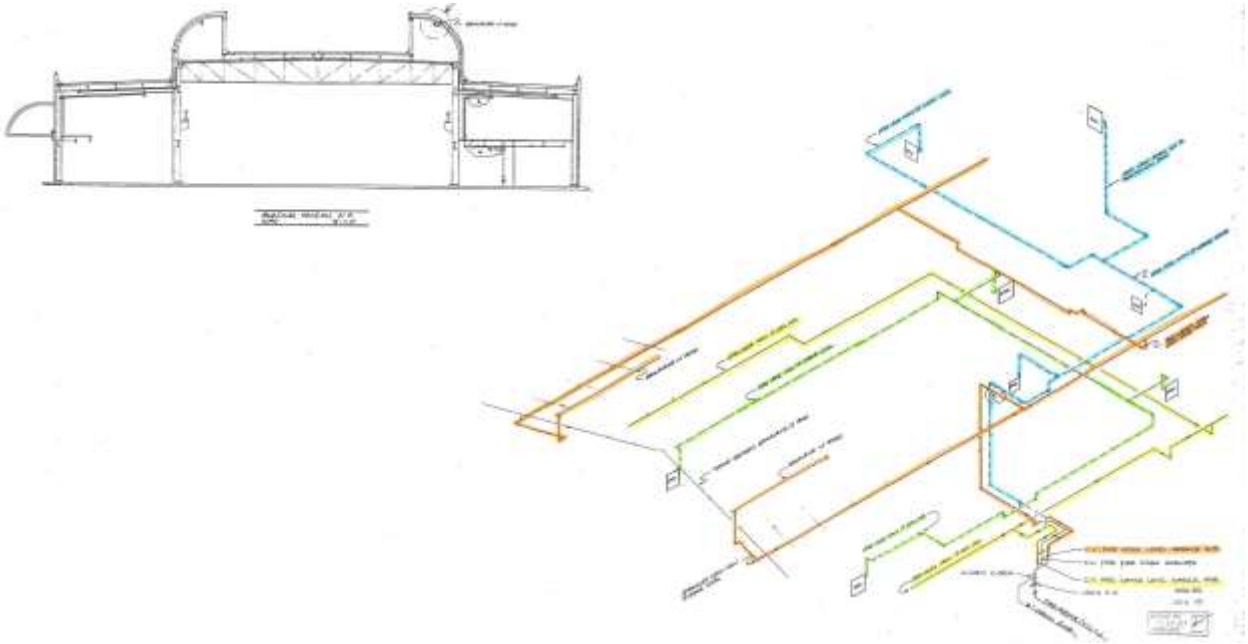


Figure 32: System Header Isometric Layout

5.1. Water Supply:

Water is supplied to the building from two firewater pumps and a 470,000 gallon tank. Fire water pumps are single stage, horizontal, split case, centrifugal pumps. Figure 33 shows an example of one of the pumps. The pumps provide the following tested pressures and flow:

Static Pressure	=	165 psi
Flowing Pressure	=	132 psi (See Appendix G for test data)
Flow	=	3002 gpm (See Appendix G for test data)

Figure 33: Firewater Supply Pump

Figure 34 below shows the design and minimum performance curves for the fire pumps. See Appendix F for overview layout of supply system.

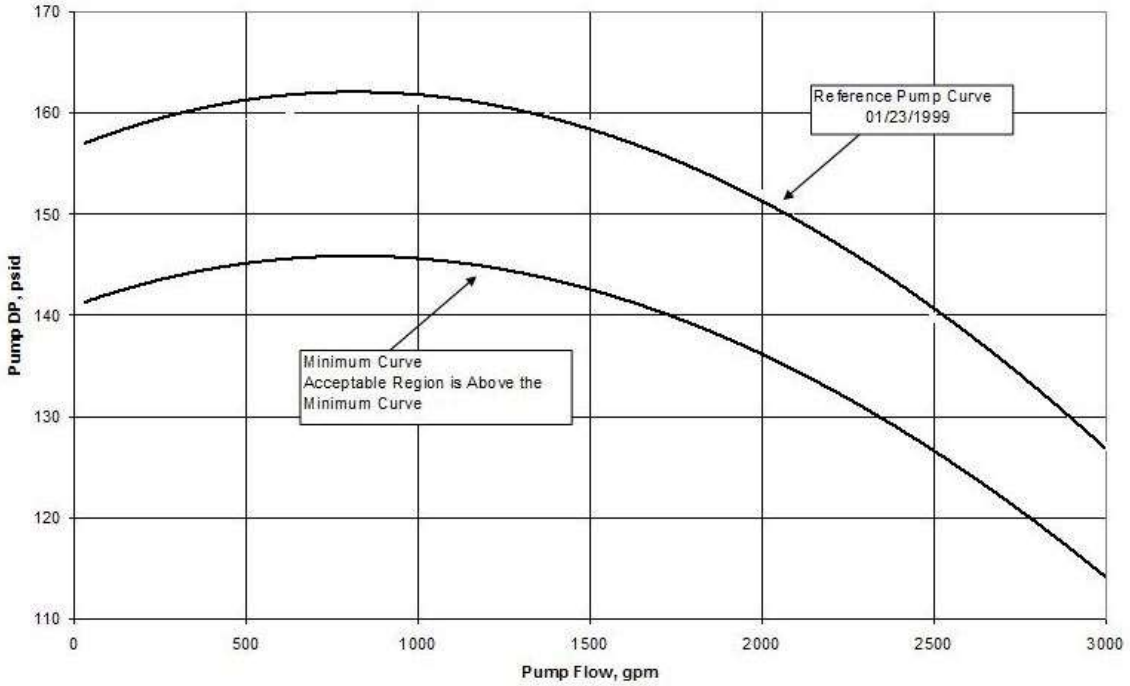


Figure 34: Fire Pump Performance Curve

Water is fed to the building via a 12" PVC main. This reduces to an 8" line that enters the building. This feed one riser that feeds both sprinkler systems and the standpipe system.

There is one Fire Department Connection at the southeast corner of the building.

5.2. Riser:

One riser manifold feeds the fire systems for the building. The riser consists of three risers; one for each portion of the system. The riser is located just inside the building one the west side just south of the midpoint. See Appendix H for piping isometrics.

5.2.1. Riser Components:

- 6" Clow Gate Valve
- 4" Reliable Check/Alarm Valve
- (2) 4" Kennedy Gate Valve
- 2.5" Kennedy Gate Valve
- V52-D Potter Electric Flow Switches
- OSYS-4 Potter Electric Tamper Switches
- HLPS Potter Electric Alarm Pressure Switch
- Schedule 40 steel pipe

5.3. Sprinklers:

The cold machine shop sprinklers were designed to an Ordinary Hazard, Group II with a density of 0.19gpm/ft^2 and an application area of 1500ft^2. Figure 22 shows the layout of the lower sprinkler system and Figure 23 shows the layout of the upper system. Based on FIGURE 11.2.3.1.1 Density/Area Curves of NFPA 13 (2013) these are not the current appropriate values for design for this building, however they were acceptable at time of design. Looking at the sprinkler layout and based on analysis performed in FPE 523 it would appear the sprinklers meet any and all spacing requirements of NFPA 13. See Appendix B for further sprinkler information.

5.3.1. Sprinkler Components:

- ½" Reliable Upright rated at 175°F / 155°F - Standard Response
- ½" Reliable Pendent rated at 175°F / 155°F - Standard Response
- 17/32" Reliable Upright rated at 175°F / 155°F - Standard Response


Upright


Pendent


Conventional

Figure 35: Sprinkler Examples

5.4. Hose Reels Stations:

A hose real system is installed on both floors of the building with stations installed throughout. These stations would be operated by the onsite Fire Department in a fire event. Employees are not trained on how to use stations and are not expected to during a fire. They would just be expected to exit the building as quickly as would be safe. The required hose stream is 250 gpm for 60-90 minutes (NFPA 13, Table 11.2.3.1.2). The system is designed and installed per NFPA 14. All piping is 4" and provides 100psi to most remote station. Figure 36 below shows an example of one of the show reel stations on the second floor of the building. Figure 37 shows the hose reel system piping layout on the 1st floor. See Appendix H for system isometrics.

Figure 36: Second Floor Hose Reel Station

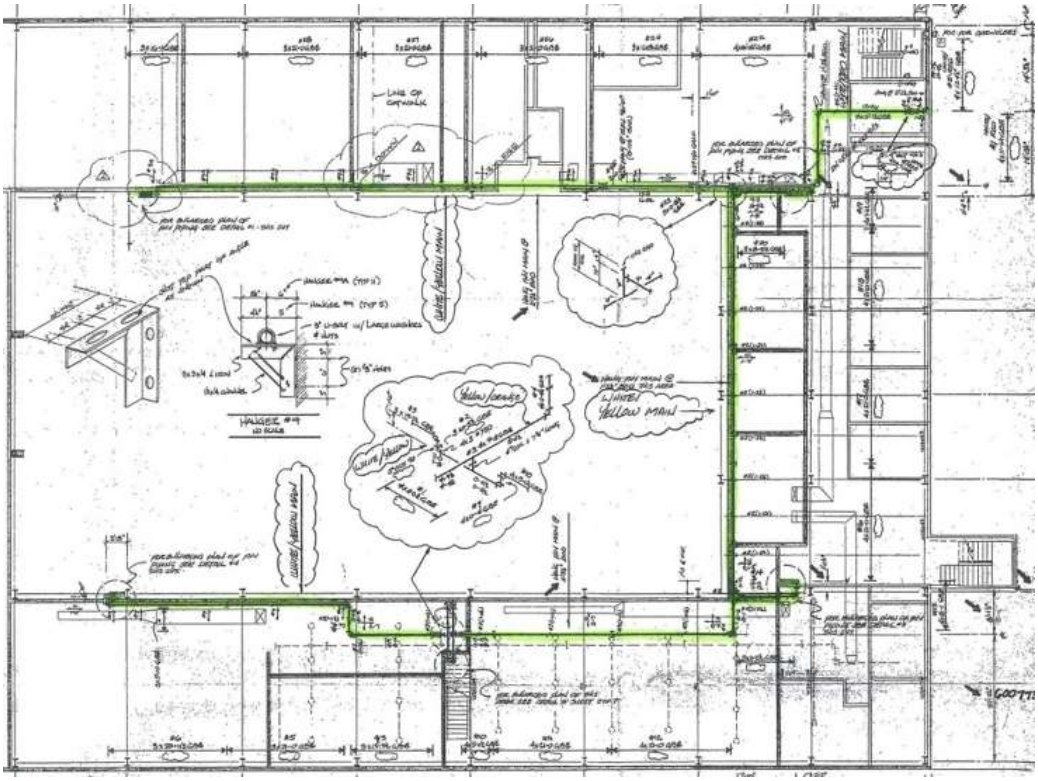


Figure 37: 1st Floor Hose Reel Layout

5.5. Hydraulic Calculations:

All piping is schedule 40 steel.

Occupation Class: Ordinary Hazard, Group II
Density: 0.19 gpm/ft^2
Area of Application: 1500ft^2
Hose Streams: 250 gpm

Differences exist in number of sprinklers per service area due to irregularities in building configuration.

5.5.1. Manual Calculations:

5.5.1.1. Lower Systems Demand:

The most demanding or remote area of the lower sprinkler system contains 17 sprinklers in its application area. These sprinklers are in the northeast corner of the non-shop areas of the first floor (Shown on Figure 22). It contains more sprinklers than the upper systems most remote area due to some irregularities around the small rooms, bathrooms and stairwell in this area.

$$Area\ per\ Sprinkler = A = \frac{1500\ ft^2}{17\ sprinklers} = 88.24 ft^2$$

$$Flow\ per\ Sprinkler = Q = AD = 88.24 ft^2 \left(0.19\ {}^{gpm}/_{ft^2}\right) = 16.765 gpm$$

$$Pressure\ per\ Sprinkler = P = \left(\frac{Q}{k}\right)^2 = \left(\frac{16.765}{5.6}\right)^2 = 8.96 psi$$

The lower system application area sprinklers require 298.8 gpm. Hose reels require 250 gpm per NFPA 13. The total required flow is 548.8 gpm. Pressure required is 135.5 psi. The water supply would easily support these values. See Appendix I for calculations.

5.5.1.2. Upper Systems Demand:

The most demanding or remote area of the upper sprinkler system contains 12 sprinklers in its application area. These sprinklers are in the north center area of the shop area (Shown on Figure 23). It contains less sprinklers than the lower systems most remote area due to its standard layout and no irregularities due to walls or bathrooms.

$$Area\ per\ Sprinkler = A = \frac{1500\ ft^2}{12\ sprinklers} = 125 ft^2$$

$$Flow\ per\ Sprinkler = Q = AD = 125 ft^2 \left(0.19\ {}^{gpm}/_{ft^2}\right) = 23.75 gpm$$

$$Pressure\ per\ Sprinkler = P = \left(\frac{Q}{k}\right)^2 = \left(\frac{24.7}{8}\right)^2 = 8.81 psi$$

The upper system application area sprinklers require 340.3 gpm. The hose reels require 250 gpm per NFPA 13. The total required flow is 590.3 gpm. Pressure required is 146.0 psi. The water supply would easily support these values. See Appendix I for calculations.

5.5.1.3. Standpipe Systems:

The lower hose reel would require 114.7psi to support the 250gpm required in NFPA 13. The upper hose reel would require 128.3psi to support the 250gpm. These are both easily provided by the water supply.

5.5.1.4. Results:

Based on the calculations, the water supply would provide sufficient volume and pressure, as shown in Figure 38 below. The demand is right at and just below the minimum performance curve for the water supply, however it is well below the tested performance curve.

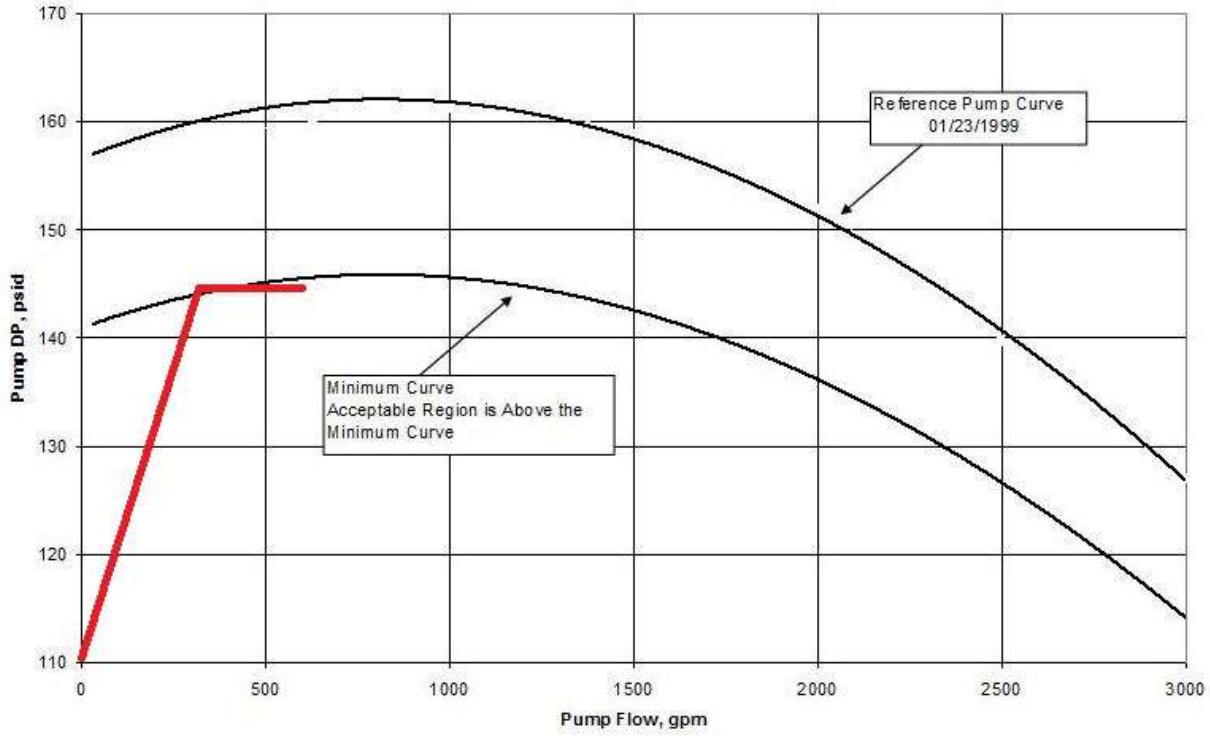


Figure 38: Water Supply and Demand

5.5.2. AutoSPRINK Calculations:

Slight layout modifications were required to ensure fittings matched up. The existing building was built in 1985 based on the 1969 version of NFPA 13 (which is the code of record onsite for NFPA 13) and many parts/fitting were fabricated onsite.

5.5.2.1. Lower Systems Demand:

Number of sprinklers in application area: 17

The lower system application area sprinklers require 360.05 gpm. Hose reels require 250 gpm. The total required flow is 610.05 gpm. Pressure required is 46.398 psi. The water supply would easily support these values. See Appendix J for calculations.

5.5.2.2. Upper Systems Demand:

Number of Sprinklers in application area: 12

The upper system application area sprinklers require 261.09 gpm. Hose reels require 250 gpm. The total required flow is 511.09 gpm. Pressure required is 63.967 psi. The water supply would easily support these values. See Appendix J for calculations.

5.5.2.3. Results:

Based on the calculations, the water supply would provide sufficient volume and pressure shown in Figure 33. The demand is well below the minimum performance curve for the water supply, and even further below the tested performance curve.

5.5.3. Overall Results:

The chart below shows a comparison of the manual and computer generated calculations for the water based suppression systems. There is a large difference in the required pressures, which could indicate an error in the manual method with regards to pressure. However if either of the values were used, it would be achievable given the high pressure supplied to the building. Differences are also seen between the manual and computer calculations with regards to flow. However in lower system, the computer is the conservative value and in the upper system the manual calculation is the conservative value. All numbers are found to be acceptable based on the water supply for the building.

Table 13: Water Based Suppression System Calculation Results

	Manual Calculations		Computer Calculations	
	Flow Demand (gpm)	**Pressure Demand (psi)**	**Flow Demand (gpm)**	**Pressure Demand (psi)**
Standpipe System	250		250	
Lower Sprinkler System	299	135.5	360	46.4
Lower System Total	549	135.5	610	46.4
Upper Sprinkler System	340	128.3	261	64.0
Upper System Total	590	128.3	511	64.0

5.6. Inspection, Testing and Maintenance Requirements:

Some inspection of the area is performed by the Fire Department Staff onsite. However the majority of inspection and testing is contracted out to vendor Costco. Maintenance is performed by the onsite maintenance personnel. The following is a list of inspections/testing performed by Cosco:

5.6.1. Inspections:

5.6.1.1. Quarterly:

- Control Valves (12.3.2.1)
- Alarm Devices (5.2.6)
- Guages (5.2.4.1)
- Pipe and Fittings (5.2.2)
- Sprinklers (5.2.1)
- Spare Sprinklers (5.2.1.3)
- Fire Department Connections (12.7.1)

5.6.1.2. Annually:

- Hangers (5.2.3)
- Seismic Braces (5.2.3)

5.6.2. Testing:

5.6.2.1. Annually:
- Alarm Devices (90sec) (5.3.3 & 12.2.7)
- Main Drain Test (12.2.6, 12.2.6.1, 12.3.3.4)
- Control Valve – Position / Operation (12.3.3.1)

5.6.3. Maintenance:

5.6.3.1. Annually:
- Control Valves (12.3.4)

5.6.3.2. 5 Years:
- N/A

5.7. Summary:

Based on NFPA 13 and 14, the Cold Machine Shop was found to meet all aspects of the code after analysis. The water supply on site (tanks and pumps) meets the demand required by the sprinklers and hose reel stations. The sprinkler system, stand pipe system, devices, layout and testing are all appropriate for the building.

The structural fire protection is the next portion of the prescriptive analysis that will be discussed. The structural portion of the building which supports all other portions of the fire protection systems. This analysis will look at building attributes versus code requirements and general fire resistance requirements.

6. Structural Fire Protection:

6.1. Building Attributes:

The building was designed as Type IIB with sprinklers. The most common use of Type IIB construction is in big box retail stores, warehouses, and industrial buildings so this is appropriate. Reference Appendix K for structural drawings and markups.

6.1.1. Use and Occupancy Classifications:

Based upon the International Building Code (IBC) the building contains three different occupancy classifications. The office area would be considered Business - Group B (IBC 304.1). The shop area would be considered Moderate-hazard Factory Industrial, Group F-1 (IBC 306.2). The areas of storage would be Low Hazard Storage, Group S-2 (IBC 311.3).

6.1.2. Building Stories:

The Cold Machine Shop has three stories. This is allowable based on the IBC. The maximum building stories for B and S-2 occupancies for a Type IIB sprinklered building is four. The maximum for F-1 classification is 3. Table 14 below shows IBC Table 504.4.

Table 14: IBC Table 504.4

ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	2	1
	S	UL	6	4	3	4	3	4	3	2
A-2	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-3	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-4	NS	UL	11	3	2	3	2	3	2	1
	S	UL	12	4	3	4	3	4	3	2
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
E	NS	UL	5	3	2	3	2	3	1	1
	S	UL	6	4	3	4	3	4	2	2
F-1	NS	UL	11	4	2	3	2	4	2	1
	S	UL	12	5	3	4	3	5	3	2
F-2	NS	UL	11	5	3	4	3	5	3	2
	S	UL	12	6	4	5	4	6	4	3
S-2	NS	UL	11	5	3	4	3	4	4	2
	S	UL	12	6	4	5	4	5	5	3
U	NS	UL	5	4	2	3	2	4	2	1
	S	UL	6	5	3	4	3	5	3	2

6.1.3. Building Area:

The total area for the Cold Machine Shop was calculated to be 35,710ft^2. The first floor is 27,000ft^2, the second floor is 7,310ft^2 and the third floor is 1,400ft^2. The building area meets the IBC for each of the building classifications including the most restrictive, F-1, which is 54,250ft^2. Sections 6.1.3.1 through 6.1.3.3 below show acceptable areas, the area increase factor, and the new calculated acceptable areas for each classification within the building.

6.1.3.1. Max Building Area per Classification (IBC Table 506.2):

- B - 69,000 ft^2 allowable area factor for SM, IIB
- F-1 - 46,500 ft^2 allowable area factor for SM, IIB
- S-2 - 78,000 ft^2 allowable area factor for SM, IIB

6.1.3.2. Max Building Area - Mixed Use (IBC Section 506.2.4):

- B - Aa = [At + (NS x If)] = [69,000 + (23,000 x .5)] = 80,500 ft^2
- F1 - Aa = [At + (NS x If)] = [46,500 + (15,500 x .5)] = 54,250 ft^2
- S1 - Aa = [At + (NS x If)] = [78,000 + (26,000 x .5)] = 91,000 ft^2

6.1.3.3. Frontage Increase (IBC Section 506.3.3):

- W = 30 ft
- If = [F/P - 0.25]W/30 = [0.75 - 0.25]30/30 = 0.5

6.1.4. Building Height:

The Cold Machine Shop is 52ft tall at its highest point. This is acceptable based on the maximum height of 75ft for all three classifications (IBC Table 504.3). Table 15 below shows Table 504.3 from the IBC.

Table 15: IBC Table 504.3

ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
H-1, H-2, H-3, H-5	NS[c, d]	UL	160	65	55	65	55	65	50	40
	S									
H-4	NS[c, d]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 1, I-3	NS[d, e]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 2, I-2	NS[c, f, e]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85						
I-4	NS[d, g]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
R	NS[d, h]	UL	160	65	55	65	55	65	50	40
	S13R	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	85	70	60

6.1.5. Materials:

The building is made up of mostly fire resistant materials. Columns and beams area made up painted structural steel I-beams, T-beams and tube steel. The elements as large as W24x146 and as small as W8x18. The floors are all concrete which was either poured on the ground or over a corrugated sheetmetal for the upper floors. The floor is covered with ceramic tile, hardener sealer, vinyl, or carpet finish. Roof areas are made up of metal siding (insulated and uninsulated) and metal decking with rigid insulation and built up roofing. Exterior walls are either poured concrete, precast concrete or glass block walls with metal frames. Consequently the interior walls are mostly masonry block walls, with some made of gypsum board, plywood and insulated metal siding. All doors and door openings are metal fire-rated assemblies. All building joints and penetrations are sealed, grouted and/or flashed and. See Section IBC 603.1 for allowable combustible materials.

6.2. Fire Resistance Requirements:

For a Type IIB building, the primary structural frame, bearing walls (exterior and interior), floor/roof construction and associated secondary members, and nonbearing walls and partitions are required to have a zero hour fire rating (IBC Table 601). No structural fire protection is required on any portion or element of the building. Table 16 below shows Table 601 from the IBC.

Table 16: IBC Table 601

FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1\frac{1}{2}$[b]	1[b, c]	1[b, c]	0[c]	1[b, c]	0	HT	1[b, c]	0

6.2.1. Required Separation of Occupancies:

Based on the IBC, the Business type occupancies and Factory occupancies do not require any type of separation (IBC Table 508.4). However the Storage areas are required to have a one hour separation from both the Business and Factory areas. The occupancy areas are separated by masonry block walls with fire doors in all cases, as well as concrete floors, thus meeting the requirements for separation. Table 17 below depicts Table 508.4 from the IBC

Table 17: IBC Table 508.4

REQUIRED SEPARATION OF OCCUPANCIES (HOURS)

OCCUPANCY	A, E		I-1[a], I-3, I-4		I-2		R[a]		F-2, S-2[b], U		B[a], F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1[a], I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R[a]	—	—	—	—	—	—	N	N	1[c]	2[c]	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2[c], U	—	—	—	—	—	—	—	—	N	N	1	2	NP	NP	3	4	2	3	2	NP
B[a], F-1, M, S-1	—	—	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2	1	NP
H-1	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP
H-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP	1	NP
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1[d]	NP	1	NP
H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP

6.2.2. Fire-Resistance Rating Requirements for Exterior Walls:

The Cold Machine Shop is not within 30ft of any other building on site. Based on the separation from another building, the exterior walls require no fire protection regardless of occupancy classification and building type (IBC Table 602). Table 18 below shows Table 602 from the IBC.

Table 18: IBC Table 602

FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a, d, g]

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H[e]	OCCUPANCY GROUP F-1, M, S-1[f]	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U[h]
X < 5[b]	All	3	2	1
5 ≤ X < 10	IA Others	3 2	2 1	1 1
10 ≤ X < 30	IA, IB IIB, VB Others	2 1 1	1 0 1	1[c] 0 1[c]
X ≥ 30	All	0	0	0

6.3. Summary:

Based upon the IBC, the Cold Machine Shop does not require any structural fire protection and none is present. All occupancies are separated by pre-formed concrete or masonry block walls, fulfilling the requirements of one hour fire separation. All building requirements based on the physical configuration of the building fall within the code; including area, height, stories and separation from other buildings.

With all aspects of the prescriptive analysis complete, the next section will provide a summary of all four aspects of fire safety that were analyzed.

7. Prescriptive Analysis Overview:

Based on the results of the prescriptive based analysis of this building, only one issue was found with the building. The building met all requirements for egress, water based suppression and structural fire protection. However, an inadequacy was found in the volume of the alarm / notification system in the shop area. While it is believed that the alarms would provide sufficient volume for the actual noise conditions in this area, the inadequacy could easily be remedied by installing an additional 2-3 alarm/notification devices. No other changes or improvements would be recommended at this time.

With all the prescriptive analysis of the Cold Machine Shop done, the performance based analysis will comprise the next section of the report.

8. Performance Based Analysis:

8.1. Overview:

The Life Safety Code aims to set "minimum requirements for the design, operation, and maintenance of building and structures for safety to life in fire" (NFPA 101 Section 1.2). NFPA 101, Section 4.2 states that a structure shall be designed to protect occupants, or provide a tenable environment, long enough for them to evacuate. Tenability criteria is the maximum exposure to a hazard an occupant can receive without being incapacitated. The Required Safe Exit Time (RSET) is the required time from ignition to completion of evacuation of all occupants that the building must stay tenable. Essentially, the time for all occupants get out of the building after a fire is ignited. The Available Safe Exit Time (ASET) is the actual or available time that the building provides a tenable environment during a fire. Both ASET and RSET include detection, recognition, response and travel times. Figure 39 below shows what all factors into RSET and ASET.

This section will perform simulations and modeling to confirm that design of the Cold Machine Shop will indeed provide (ASET) adequate safety to occupants throughout a fire (RSET).

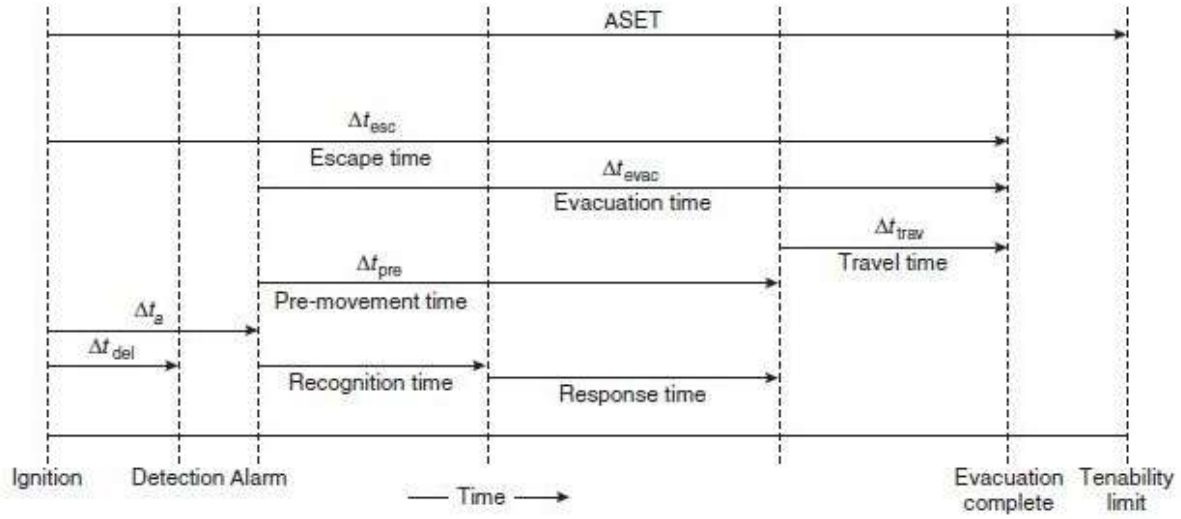


Figure 39: ASET vs. RSET

8.2. Egress - Pathfinder:

An egress modeling program, Pathfinder, was used to determine the time it would take occupants to exit the Cold Machine Shop. This value would be the travel time during a fire and will factor into determining the RSET. A model of the building was built in Pathfinder using exact dimensions from architectural drawings. It does not include furniture or tools that are installed in the building. The building was populated using the occupant loads calculated in Section 3. This assumes the maximum amount of people that could be expected to be in the building. As discussed previously, this value is believed to be a gross over estimation as the people who work in the shop area are the same employees who occupy the office areas. I believe the actual maximum occupants for this building to be about half of this value. The model was initially run with all exits available. The large shop door was omitted. While it is usually open, if it were not for some reason, it would not be a feasible egress point. All occupants in the model start moving at the same time. Figures 40, 41 and 42 show the design and layout of each floor of the model.

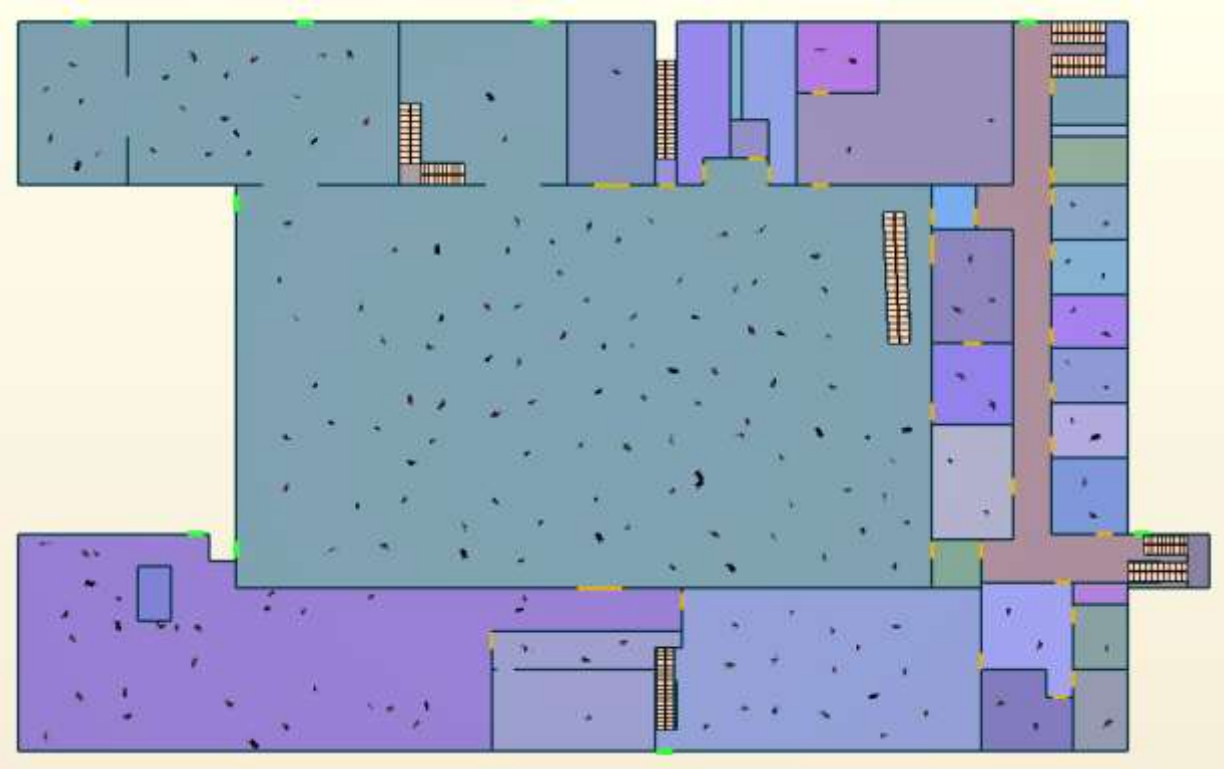


Figure 40: First Floor Pathfinder Model

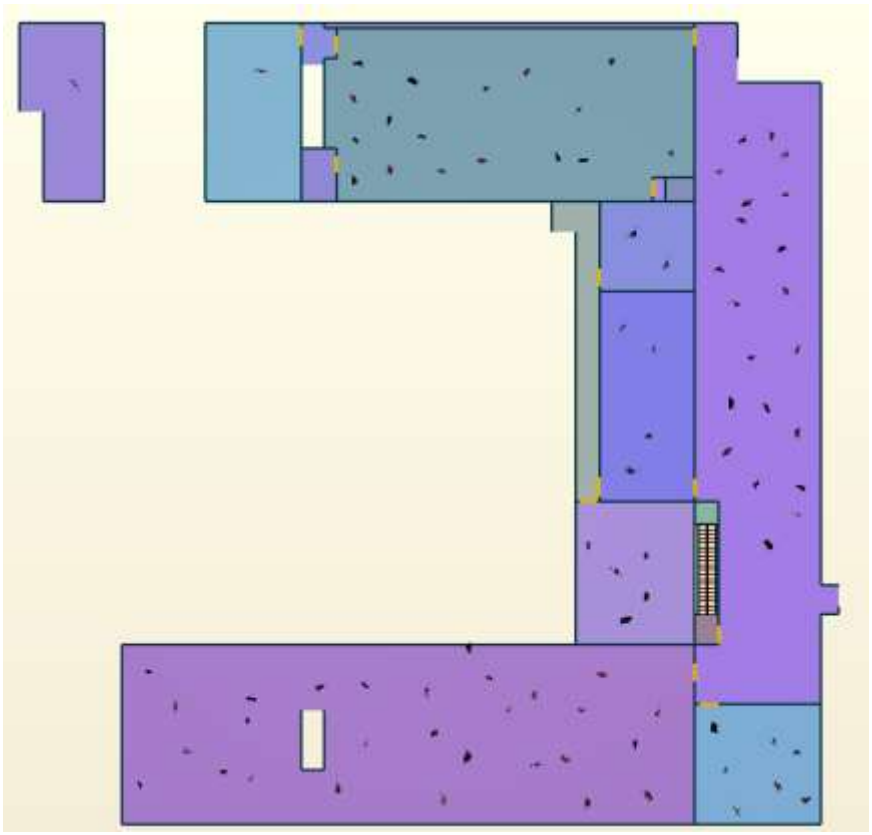


Figure 41: Second Floor Pathfinder Model

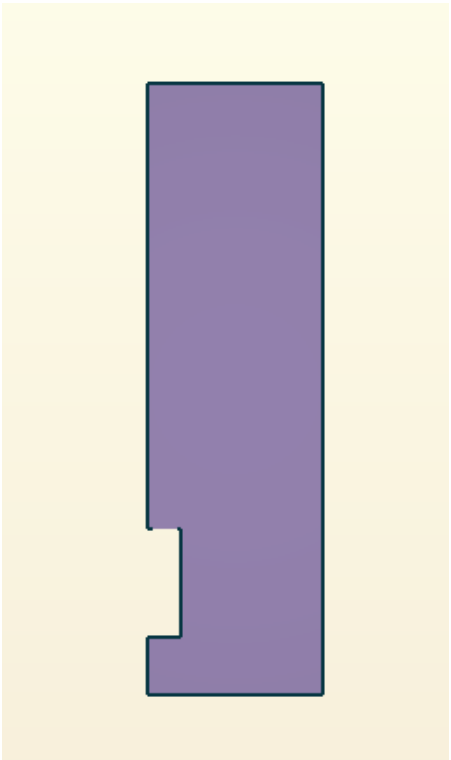


Figure 42: Third Floor Pathfinder Model

8.2.1. Results:

The Pathfinder simulation was run and produced a total egress time of 60 seconds. This is 14 seconds longer than the 46 second egress time found in Section 2 using the SFPE formula. I find this value to be a more reasonable number, however both show a quick egress for a building of this size. See figures below for graph of occupant load over time and images of simulation showing occupant locations.

8.2.1.1. The following rooms used for design fires were found to have the following egress times:

8.2.1.1.1. 2nd floor weld room cleared in 20s
8.2.1.1.2. 2nd floor electrical offices cleared in 42s
8.2.1.1.3. 1st floor shop area cleared in 34s

8.2.1.2. The following areas were found to be the bottleneck areas:

8.2.1.2.1. Second Floor: South two stairwells and west stairwell

8.2.1.2.2. First Floor: Northwest doors and east middle door

See below figures for representation of exit times and characteristics. Appendix L shows occupant movement during the simulation.

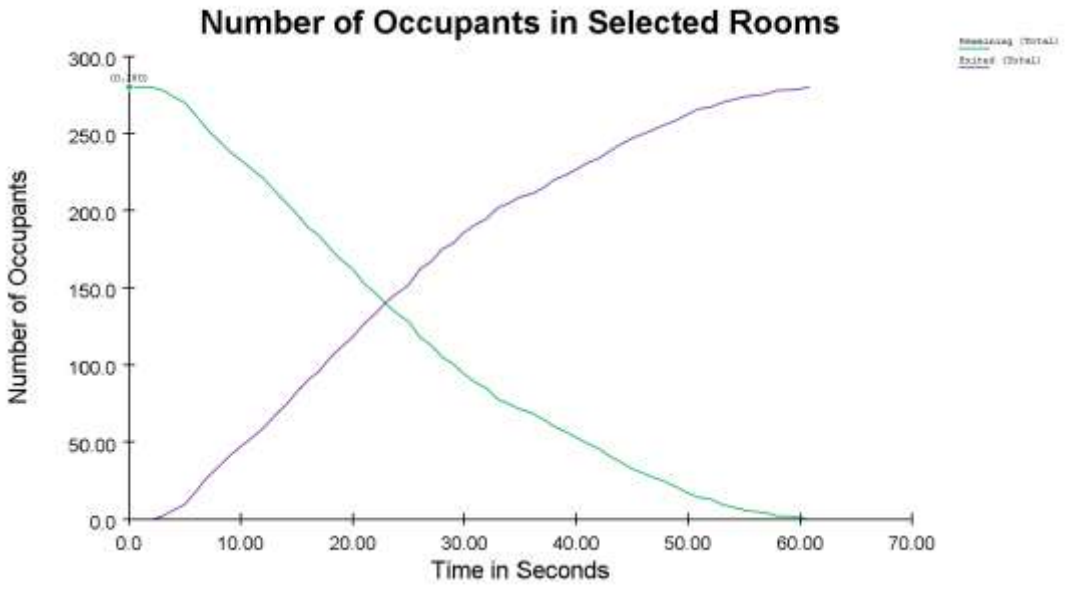


Figure 43: Building Occupant Load vs. Time

8.3. ASET / RSET - Pyrosim and FDS

8.3.1. Design Fires:

8.3.1.1. Pallet Fire:

Given that the majority of the building is used as a machine shop, it is feasible for there to be pallets for receiving and sending materials. It would be reasonable for the pallets to be stacked in a location next to one of the columns. Smoke is removed / allowed to flow out of the area from open louvers / vents located on the roof. These louvers / vents are fixed and stay open at all times. The fire design characteristics below are based on the maximum heat release rates for warehouse materials as provided in NFPA 72. This data assumes that the pallets are stacked 10ft high. One stack of pallets piled 10ft would not be out of the question for a machine shop of this size. The heat release rate per unit floor area is for fully involved combustibles, assuming 100 percent combustion efficiency. No HRR curve was provided with this data. Figure 44 below shows the HRR for this fire based on the parameters laid out below and calculated by Pyrosim. Figures 45 and 46 show the model as built in Pyrosim.

Fire Parameters (NFPA 72, Table B.2.3.2.6.2(a)):

- Growth Time = 80-110s
- Heat Release Density = 6810 kW/m^2
- Classification = Fast
- Area = 1.1m x 1.2m = 1.32 m^2
- Peak HRR = 8989 kW
- Fuel Load Density = 1671 MJ/m^2 (Average of maximums for storage) (Determining Design Fires for Design-level and Extreme Events Richard W. Bukowski, P.E., FSFPE NIST Building and Fire Research Laboratory Gaithersburg, Maryland, 20899 USA)

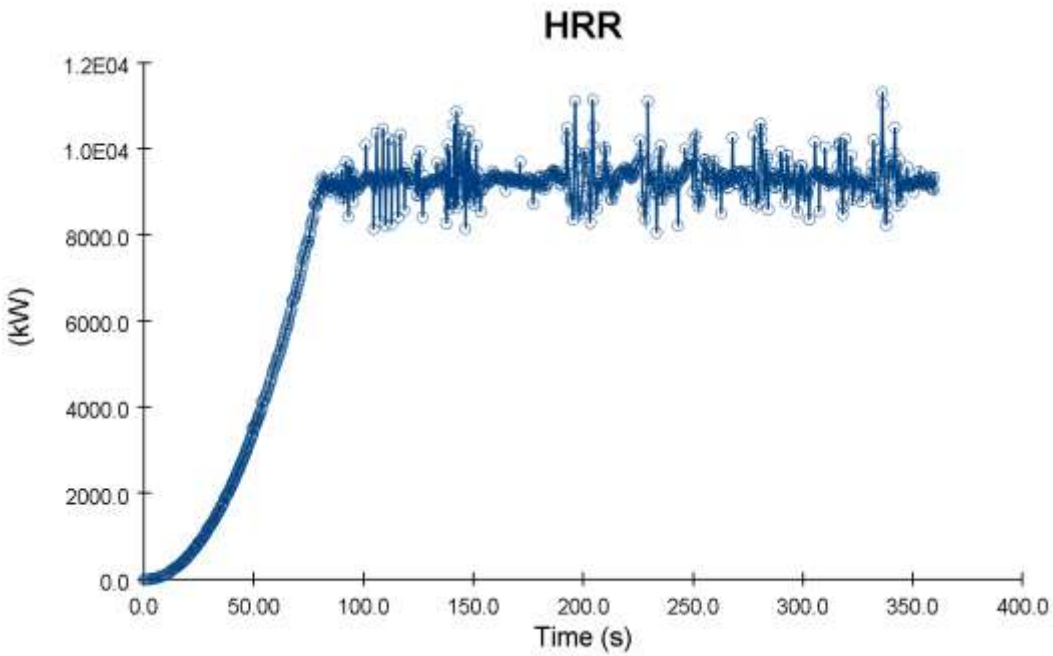


Figure 44: Pallet Fire HRR vs. Time

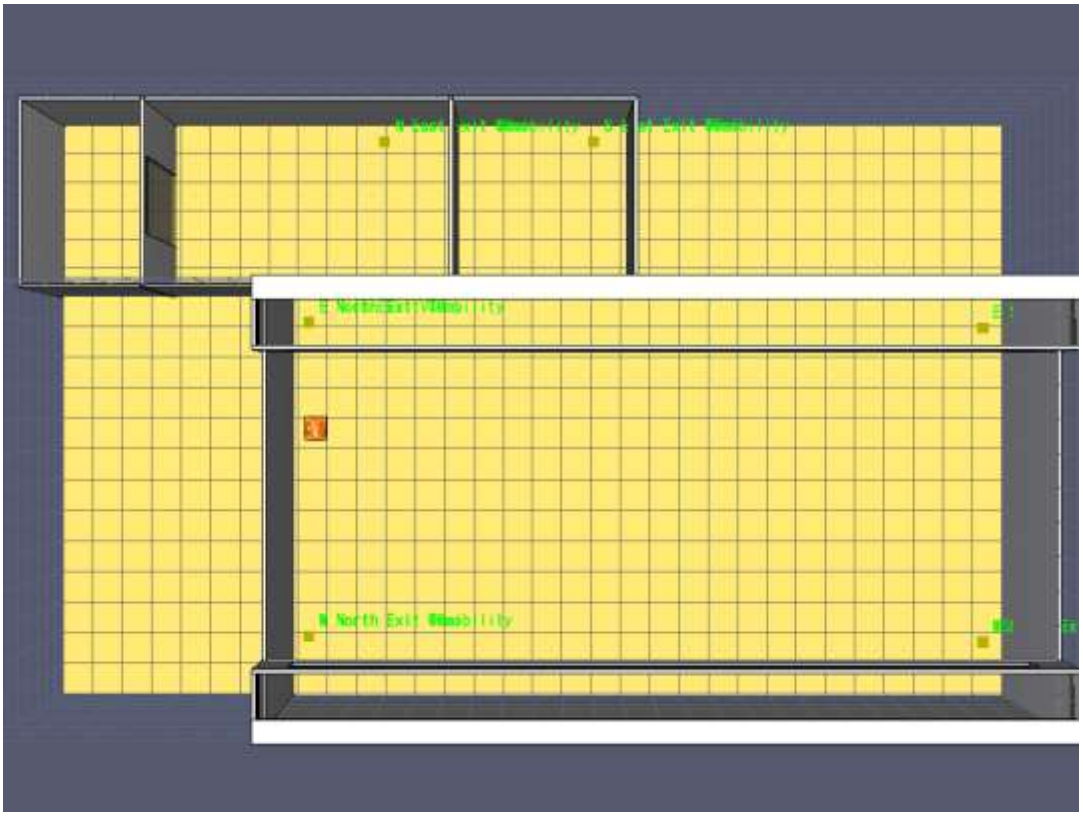


Figure 45: Pallet Fire Model

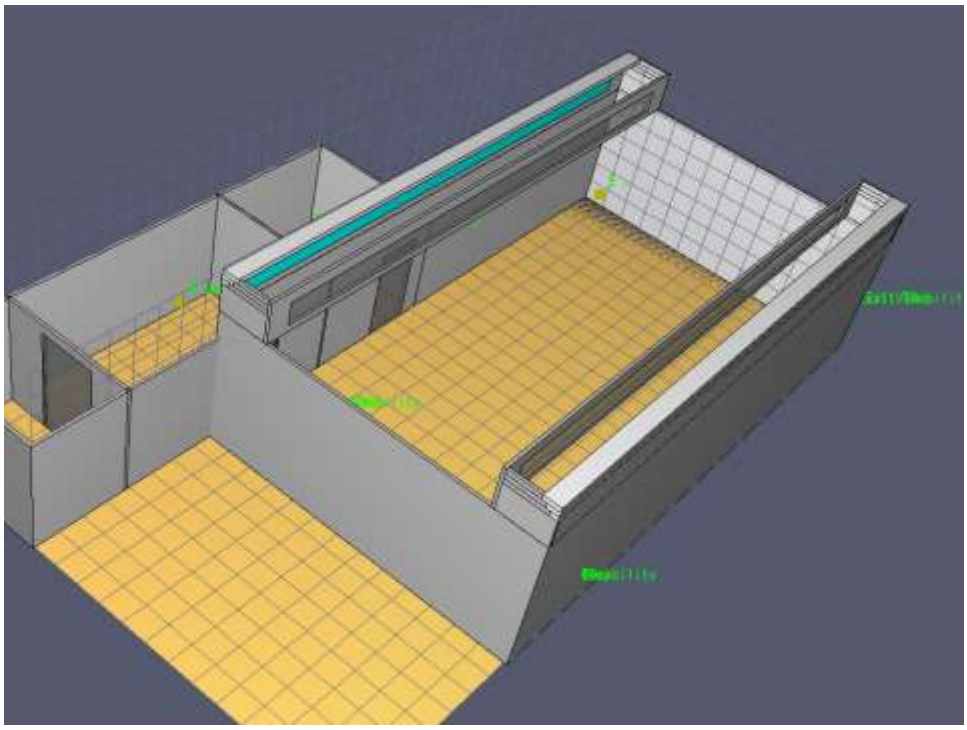


Figure 46: Pallet Fire Model Perspective View

8.3.1.2. Office Fire:

The second design fire evaluated was an office fire in the conference room in the southwest corner of the second floor of the building. There are no means of smoke removal from the second floor areas as there is with the shop area. The model assumes that the fire burns throughout the simulation with no extinguishment. Figure 47 below shows the HRR for this fire based on the criteria laid out below and calculated by Pyrosim. Figures 48 and 49 show the layout of the Pyrosim model.

Fire Parameters:

- Fire Load Density = 420 MJ/m^2 (SFPE Handbook 5th Edition, Table 35.3)
- Area = Conference Room on second floor
- Peak HRR = 35 - 70 kW/m^2 (OFFICE WORK STATION HEAT RELEASE RATE STUDY: FULL SCALE vs. BENCH SCALE by Daniel Madrzykowski Building and Fire Research Laboratory National Institute of Standards and Technology Gaithersburg, MD 20899)
- Burn Time = 420 / 70 x 1000 = 6000 s

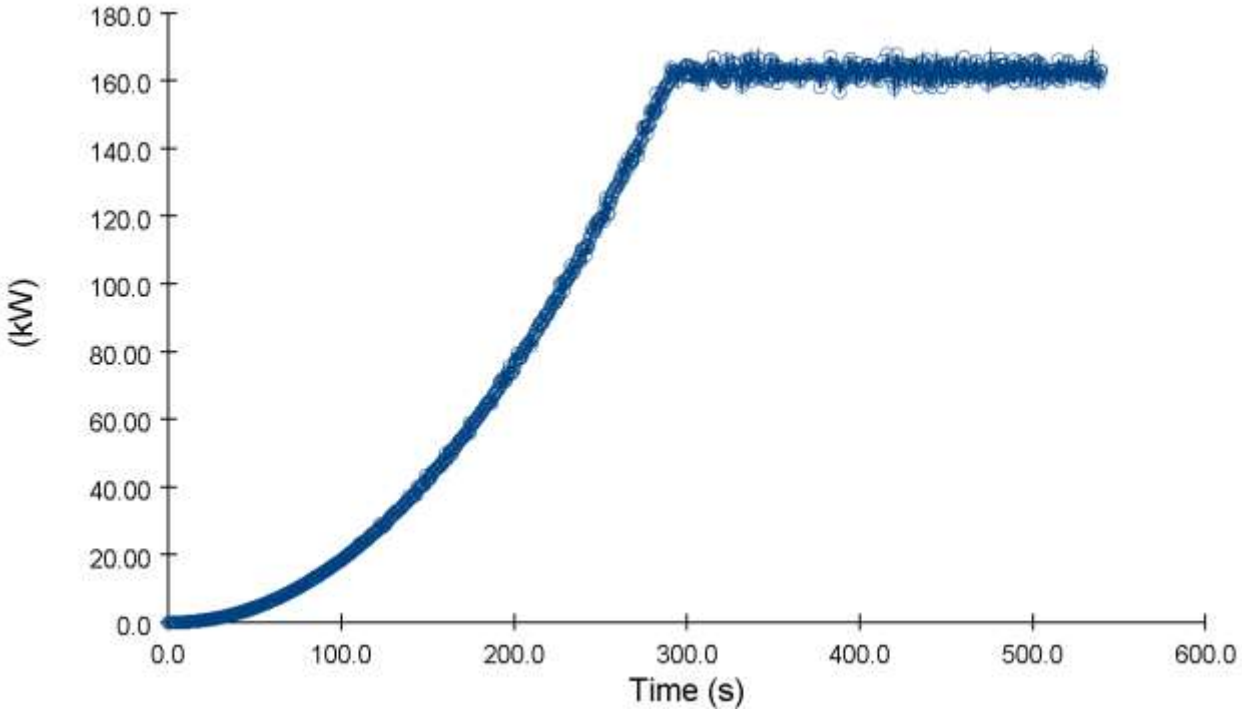


Figure 47: Office Fire HRR vs. Time

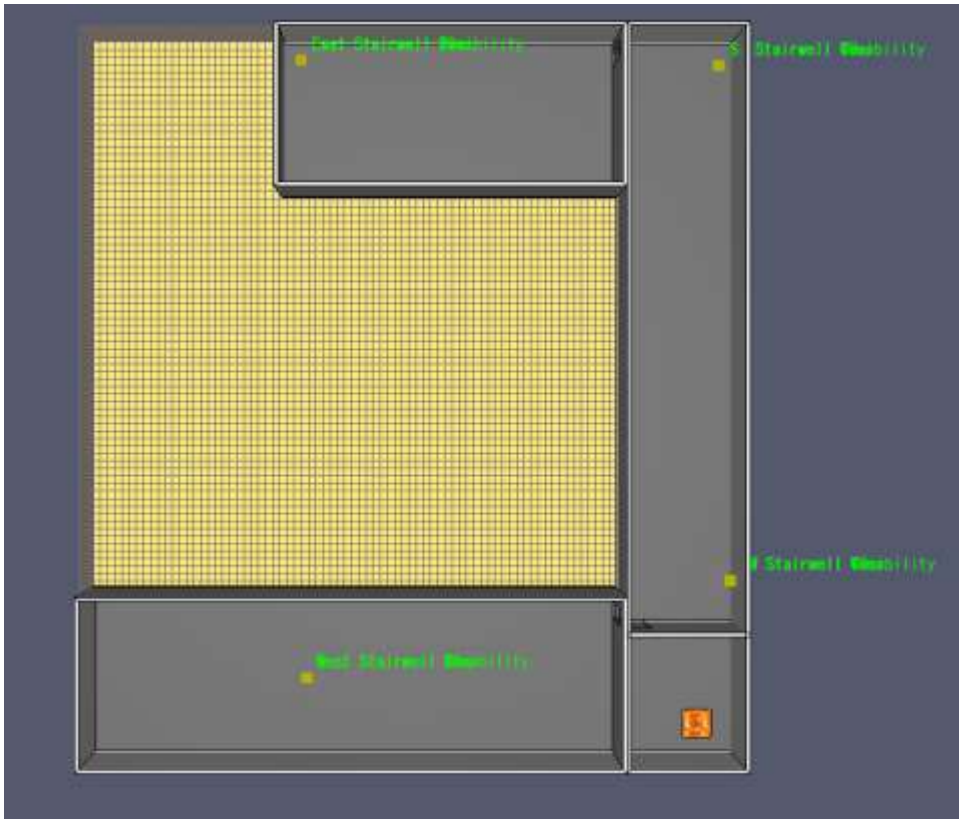


Figure 48: Office Fire Model Layout

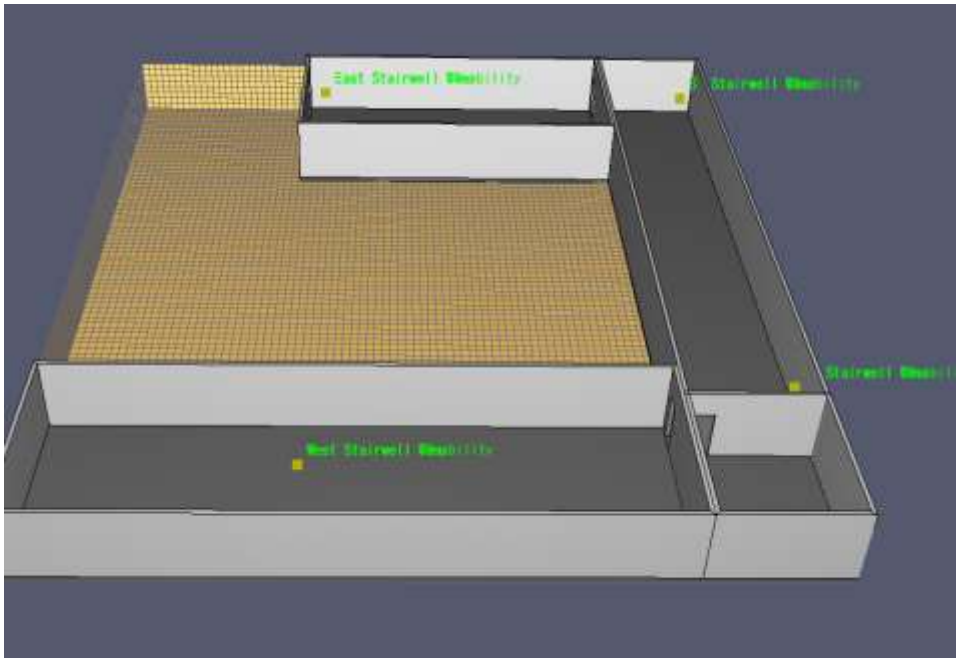


Figure 49: Office Fire Model Perspective View

8.3.2. RSET:

The factors to be taken into account for RSET are detection time, pre-movement time, travel time and a safety factor. Detection time was based on the sprinkler actuation time from Pyrosim/FDS simulations. Sprinklers actuated at 84s for the shop area and 208s for the office area. Based on research a pre-movement time of 66 seconds was considered as a mid -rise office building is similar to the Cold Machine Shop (Table 4.2.1 of the 20th edition of the NFPA Fire Protection Handbook – Mid-rise office building, mean pre-movement time). A travel time of 60 seconds was used, which came from the previously performed Pathfinder simulation. All values used factoring into the RSET are conservative, thus it seems reasonable to use a safety factor of 1.25. Accounting for all the values above, the RSETs for each area is calculated below:

- Shop Area Pallet Fire RSET: 263 seconds
- Office Area Fire RSET: 418 seconds

8.3.3. Tenability Limits:

To analyze the fire, criteria must be set for tenability. Limits must be set to ensure proper safety of the occupants of the building. All limits are evaluated at 6ft off the ground at egress points. Temperature limits are set to ensure occupants do not suffer hyperthermia (heat stroke), skin burns and/or respiratory tract damage. A value of 60°C/140°F was chosen as the most conservative as it would allow 30 minutes of safety. Mode of heat transfer for this value is convection. Visibility limits are set because smoke can impair an occupant's ability to find a safe exit. Based on the assumption that the Cold Machine Shop areas would be considered large enclosures, at value of 10m of visibility was chosen.

While occupants are familiar with the building (4m required visibility) and perhaps the areas could be considered small enclosures (5m of required visibility), the conservative number was chosen due the large enclosure criteria. Toxicity of the gas in a fire is the final tenability item. As fires burn they produce effluents that can incapacitate a person. If a person becomes incapacitated then they no longer will be able to exit the building and may suffer a causality. For the simulations, a limit of 800ppm was chosen as an acceptable value for less than 15 minutes of exposure. An occupant receiving this amount of CO, or less, would not become incapacitated during the fires, thus allowing them to egress the building. This assumes an exposure of less than 15 minutes.

- Temperature Limit: 60°C/140°F at 6ft (SFPE Handbook, 5th Edition, Table 63.20)
- Visibility Limit: 10m at 6ft (SFPE Handbook, 5th edition, Table 63.5)
- Toxicity: 800ppm CO (NFPA Committee Input No. 77-NFPA 130-2014)

8.3.4. Results:

8.3.4.1. Pallet Fire:

After running the simulation, five of the six exits from the shop area provided ASET > RSET. The exit closest to the fire reach unacceptable temperatures and visibility. With the assumption this exit is unavailable, Pathfinder was rerun. It showed an exit time for the area of 42 seconds verse the 34 seconds calculated with all exits available. The total building exit time did not change. While the temperature was not above acceptable limits at the times below, it was above 60°C at other times throughout the simulation. See the Table 19 below for tenability results at 245s / 263s (Detection time + Pre-Action time + Shop Area egress time / Total RSET). Figure 50 shows each exit temperature versus time during the simulation. It shows how most exits stay below 40°C throughout, while the northeast exit is above 60°C throughout. Figure 51 shows the visibility versus time throughout the fire. Figure 52 below depicts exits passing and failing tenability criteria. It would seem that the high ceilings and open louvers / vents on the roof allow the conditions to stay tenable at the six exits. See Appendix M for visual smoke and temperature profile simulation results.

Table 19: Pallet Fire Simulation Tenability Results

Door	Temperature (°C)		Visibility (m)		CO Concentration (ppm)	
	245s	263s	245s	263s	245s	263s
North (West)	33.4	30.6	11.3	14.7	7.3	5.6
North (East)	95.2	44.5	2.6	8.4	37.5	10.1
East (North)	30.7	29.7	15.5	17.8	5.3	4.6
East (Middle)	31.0	32.5	17.7	15.5	4.6	5.3
East (South)	29.5	30.5	17.5	13.5	4.7	6.1
South (West)	31.8	30.7	15.4	14.4	5.3	5.7
South (East)	25.3	30.9	22.4	13.2	3.6	6.2
Sprinklers actuate at 84s (Detection time)						

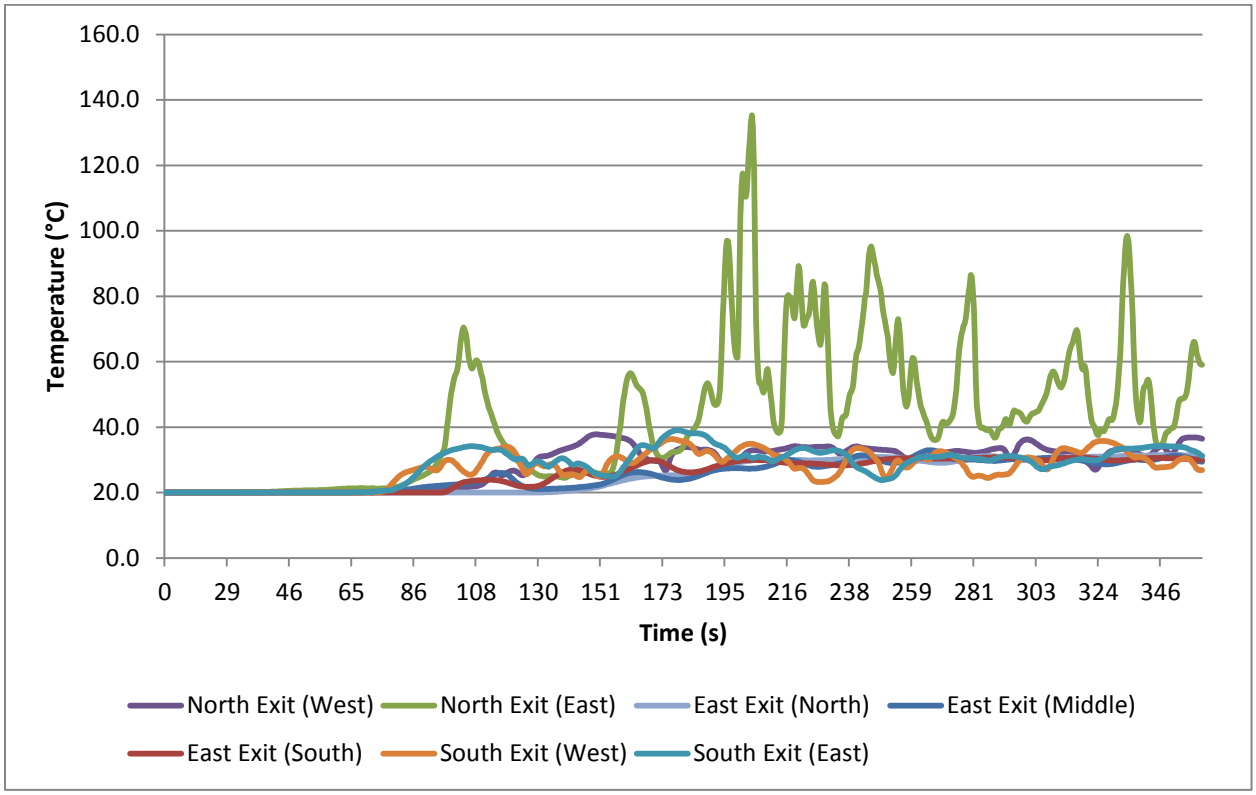


Figure 50: Exit Temperatures vs. Time

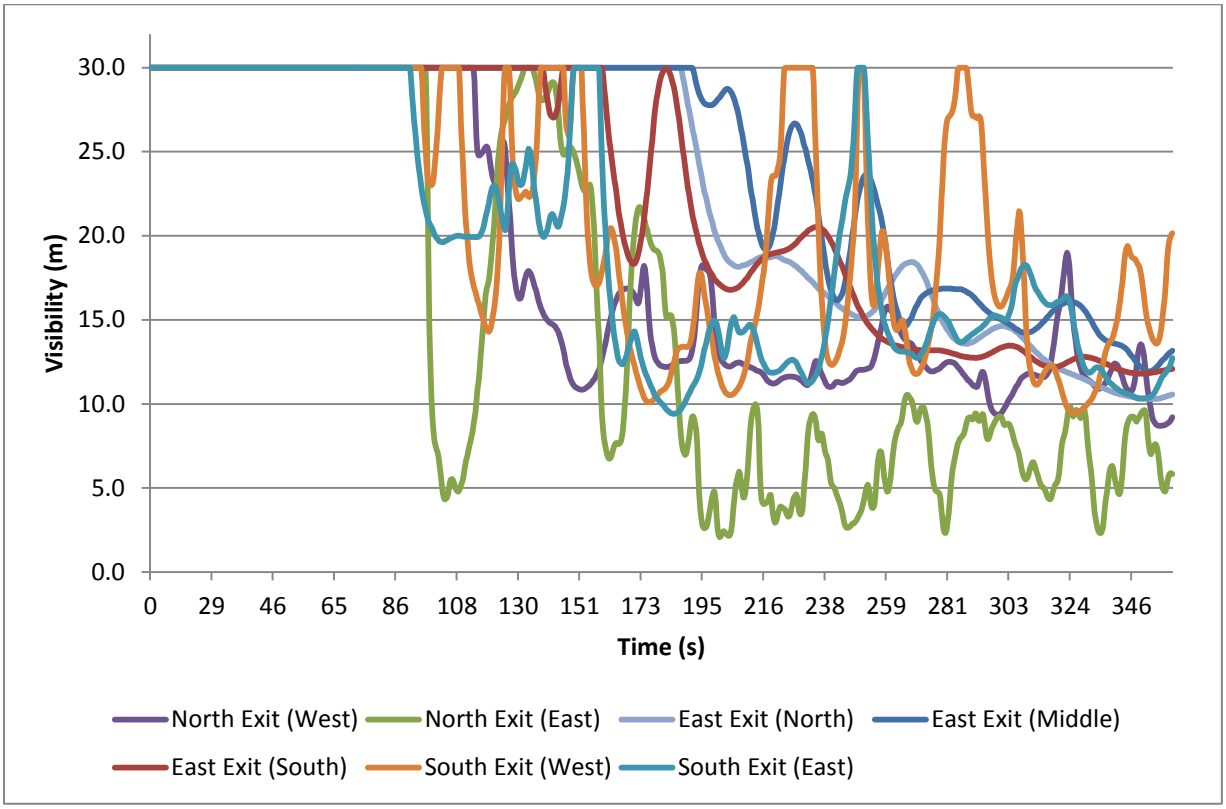


Figure 51: Pallet Fire Visibility vs. Time

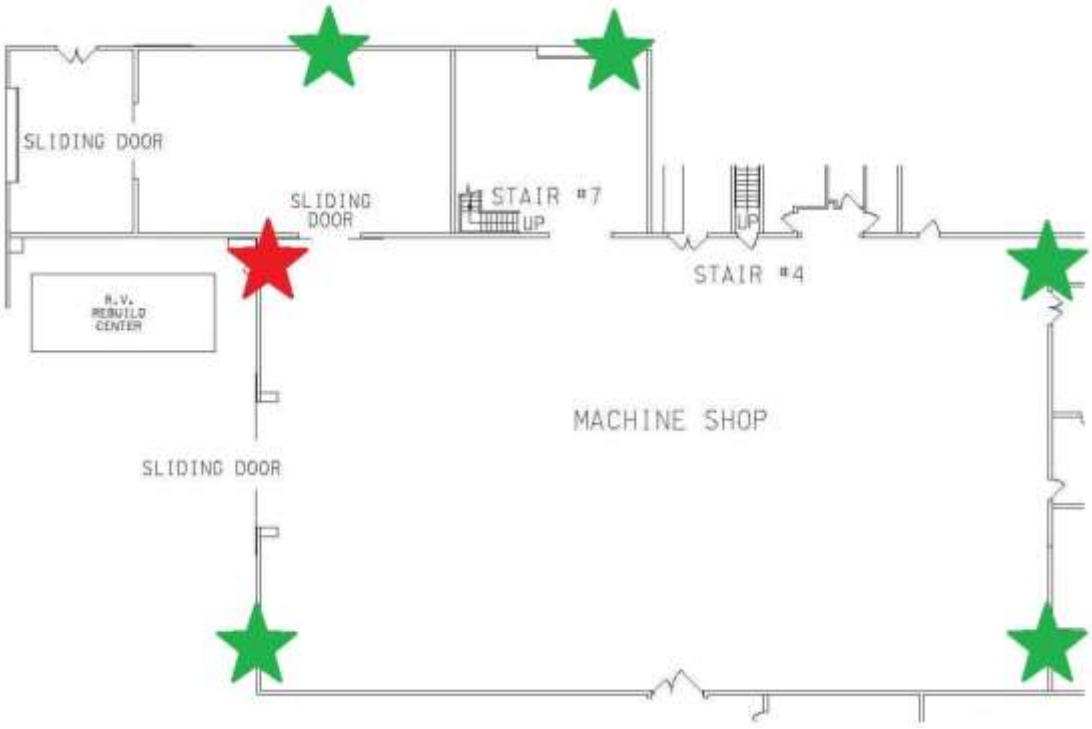


Figure 52: Pallet Fire Exit Tenability

8.3.4.2. Office Fire:

After running the simulation, two of the four exits from the second floor provided ASET > RSET. These were the two exits farther away from the fire. The two exits in the room just outside the conference room have unacceptable visibility at the RSET for either the floor or building. The required visibility is 10m and both exits had a visibility just over 1m. Even if you relaxed the criteria to 5m based on small enclosures and travel distances, these exits would not have acceptable numbers. All four exits had acceptable temperatures (below 60°C) and CO concentrations (below 800ppm) throughout the simulation. With the two unacceptable exits omitted due to the conditions, the Pathfinder simulation was rerun. During this simulation, the floor cleared in 85 seconds and the building was cleared in 95 seconds. They both had unacceptable visibility at time 376s (Pre-Action time + Second Floor exit time) and 418s (Total RSET). See Table 20 for tenability results at the time of the second floor clearing and total building egress. Figures 53, 54 and 55 show tenability data versus time for each exit. See Figure 56 below for visualization of exits passing and failing tenability criteria. Appendix N contains simulation visual results.

Table 20: Office Fire Simulation Tenability Results

Stairwell	Temperature (°C)		Visibility (m)		CO ppm	
	376s	418s	376s	418s	376s	418s
West	21.1	21.2	30.0	30.0	0.0	0.0
South (West)	34.4	35.1	1.3	1.1	0.0	0.0
South (East)	30.6	31.4	1.7	1.4	0.0	0.0
East	21.1	21.6	29.7	12.5	0.0	0.0
Sprinklers actuate at 208s (Detection time)						

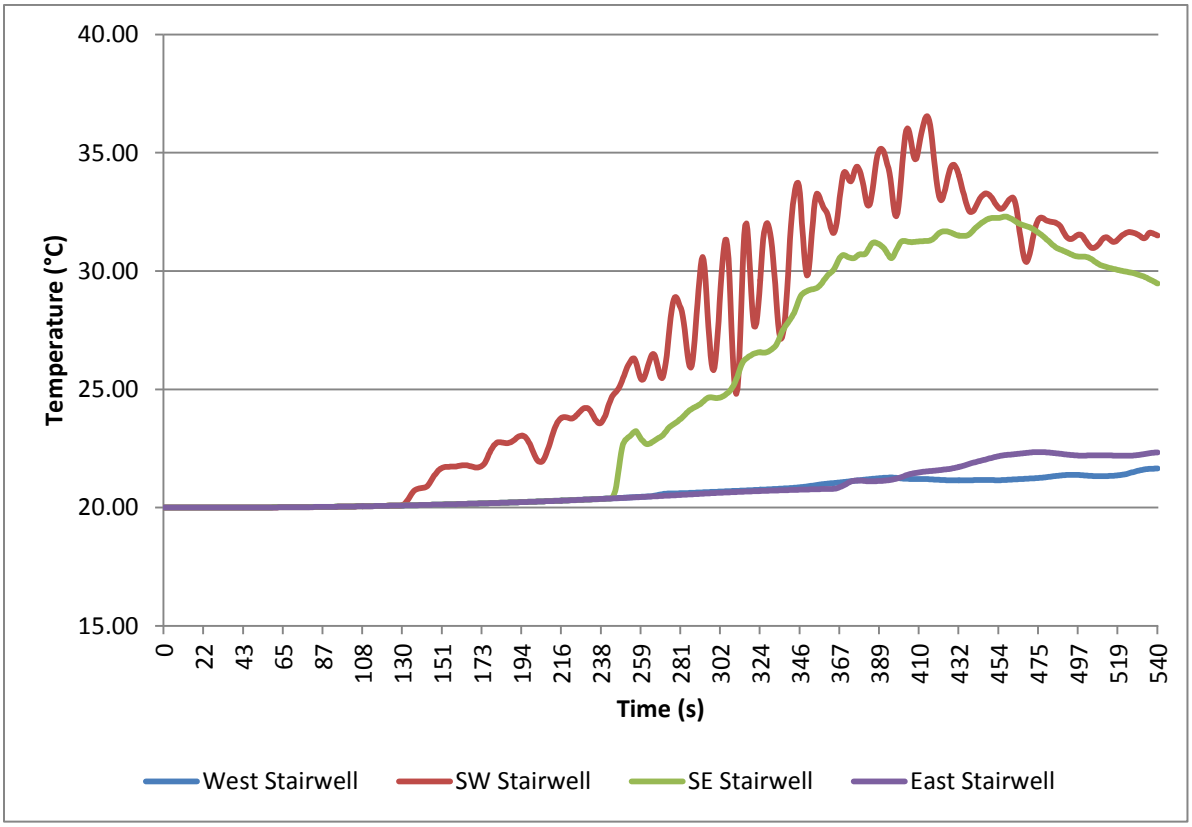


Figure 53: Office Fire Exit Temperatures vs. Time

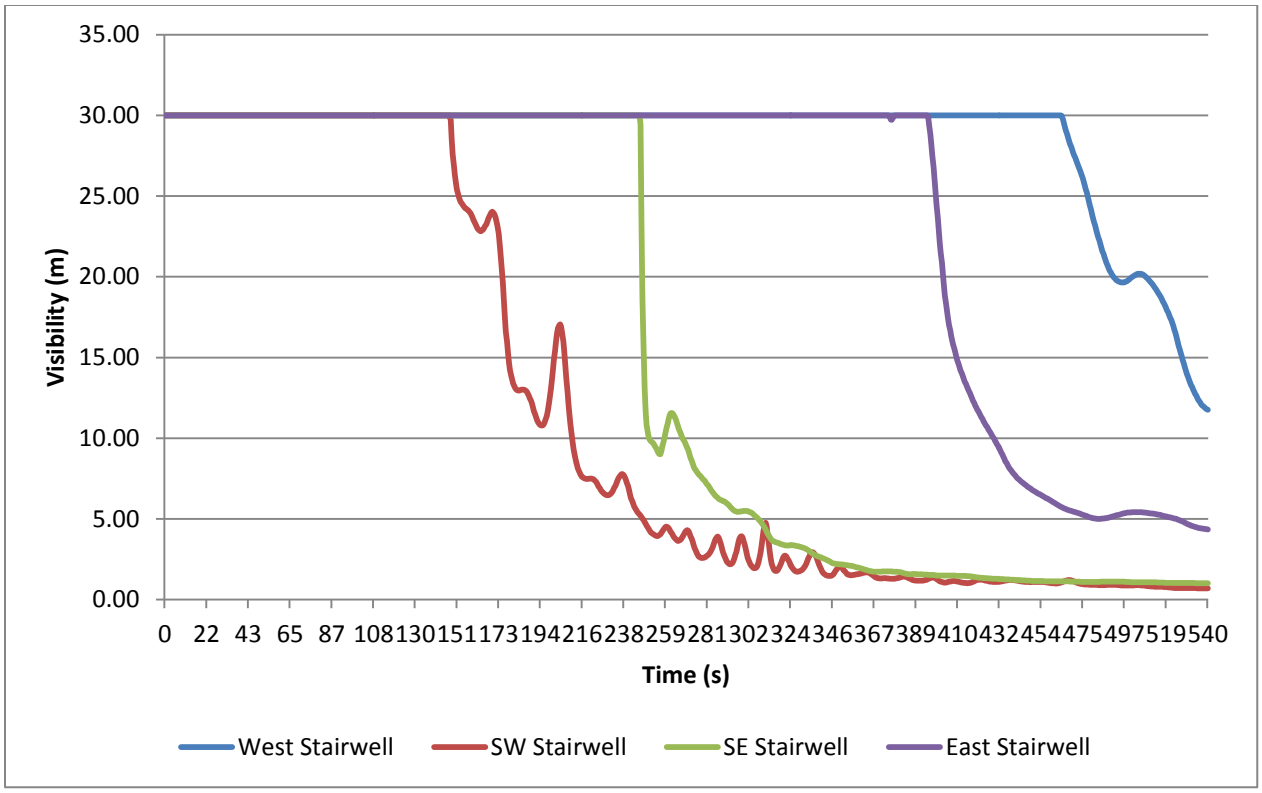


Figure 54: Office Fire Exit Visibility vs. Time

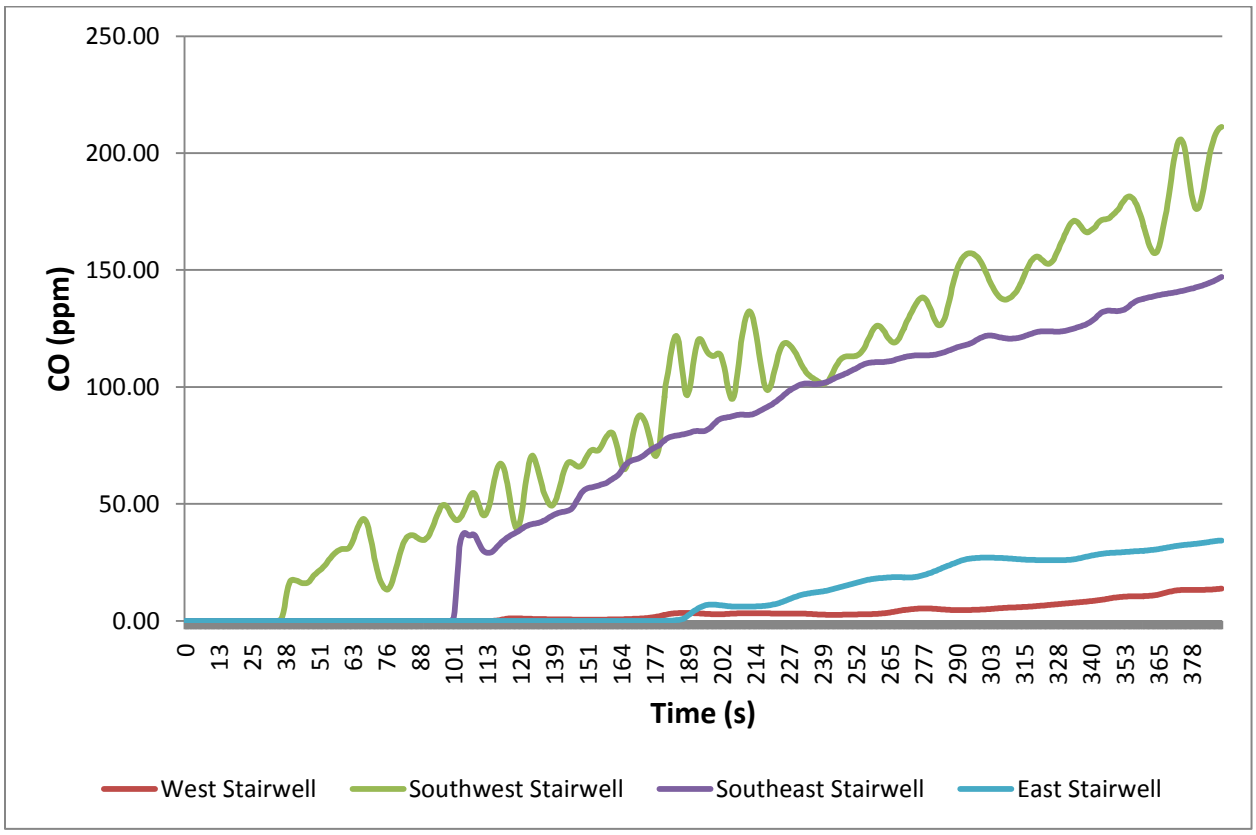


Figure 55: Office Fire CO Concentration vs. Time

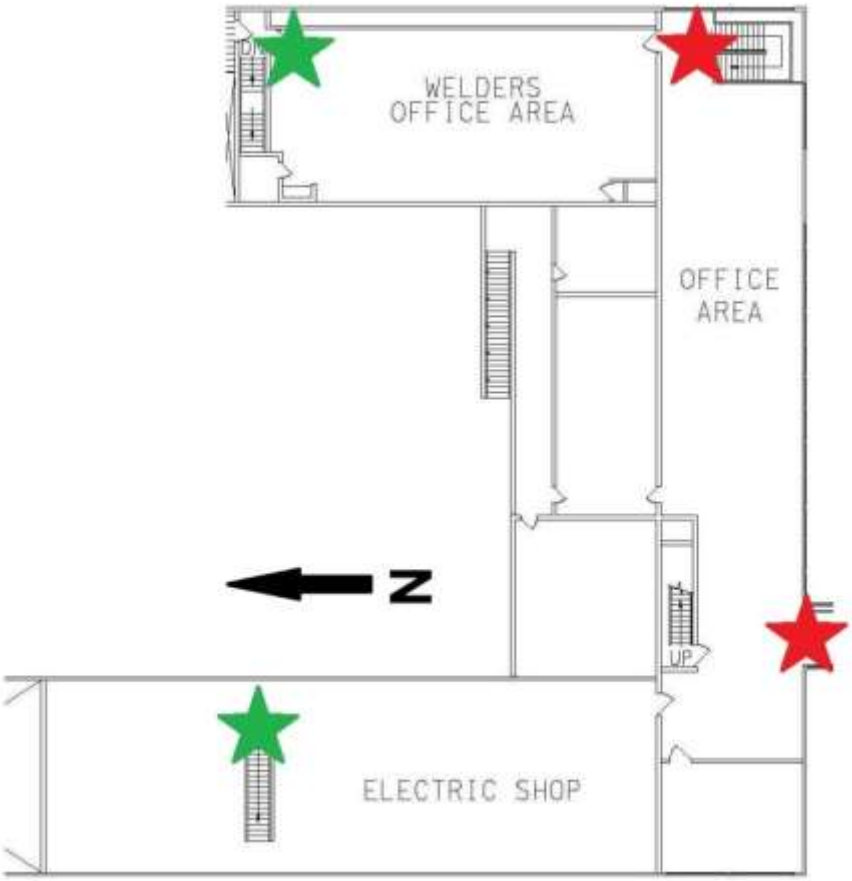


Figure 56: Office Fire Exit Tenability

9. Conclusion and Recommendations:

Based on the results of both the prescriptive and performance based analysis of this building, very few issues were found with the building. The building met all prescriptive requirements analyzed other than an inadequacy in the volume of the alarm system in the shop area. While it is believed that the alarms would provide sufficient volume for the actual noise conditions in this area, the inadequacy could easily be remedied by installing an additional 2-3 alarm/notification devices. During the performance based analysis, it was determined that a fire in the second floor conference room would not inhibit occupants from having the required time exit while tenability conditions are met for two of the four exits from this floor. The southern two exits did not have the required visibility to allow safe egress. These two exits are the two exits in the room just outside of the conference room and the first to receive smoke, thus these results are expected. Visibility was as low as 1.2m during the fire, well below the required 10m of visibility. Temperature and CO concentrations were acceptable at all four exits throughout the fire. The analysis of the shop area pallet fire showed that visibility fell below 10m and temperature went above 60°C at the northeast exit from the area. This is expected as it is the closet exit to the fire. These values do not meet the tenability criteria previously laid out in this report. However the remaining six exits were tenable throughout the simulation. Wood pallets could be disallowed in the building, as they have been in other areas on site, to reduce any risk further. They could be replaced with metal pallets and avoid this hazard altogether. Overall the building was found to be in satisfactory condition and designed appropriately.

10. References:

- PG&E Spec 7910, Section 15C
- NFPA 13: Standard for Installation of Sprinkler Systems (1969 / 2013)
- NFPA 14: Standard for the Installation of Standpipe and Hose Systems (1970 / 2013)
- NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (2014)
- NFPA 72: National Fire Alarm and Signaling Code (2016)
- NFPA 72A: Local Protective Signaling Systems (1967)
- NFPA 72D: Proprietary Protective Signaling Systems (1967)
- NFPA 101: Life Safety Code (2015)
- International Building Code (IBC) - 2015

Appendix A: Panel Information

JOHNSON CONTROLS

June 24, 2004 JCI-6880

IFC-3030

Intelligent Addressable Fire Alarm System

General

The **IFC-3030** is an intelligent Fire Alarm Control Panel designed for medium- to large-scale facilities. Fire emergency detection and evacuation are extremely critical to life safety, and the IFC-3030 is ideally suited for these applications.

The IFC-3030 is ideal for virtually any application because it features a modular design that is configured per project requirements. With one to ten Signaling Line Circuits (SLCs), the IFC-3030 supports up to 3,180 intelligent addressable devices.

Information is critical to fire evacuation personnel, and the IFC-3030's large 640-character Liquid Crystal Display (LCD) presents vital information to operators concerning a fire situation, fire progression, and evacuation details.

A host of other options are available, including single- or multichannel voice; firefighters telephone; LED, LCD, or PC-based graphic annunciators; fire or integration networking; advanced detection products for challenging environments, and many additional options.

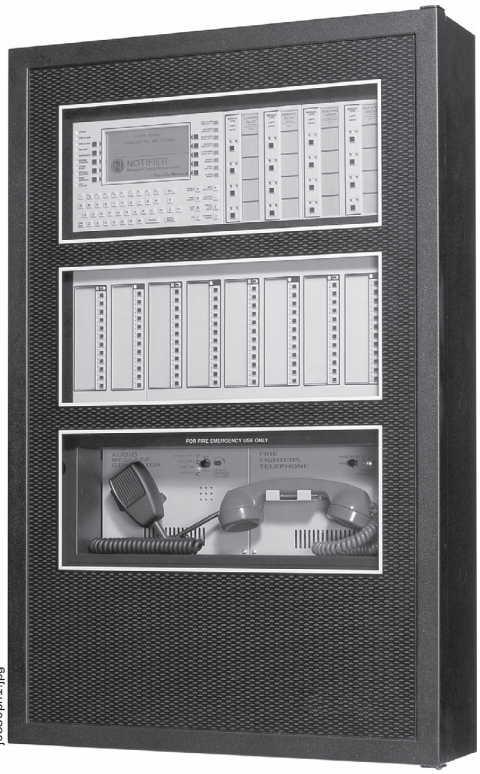
UL LISTED S1570

FM APPROVED

California State Fire Marshal 7165-0554:149 7170-0554:150

ULC CS118 Vol. 25/ S635 Vol. 46

MEA 345-02-E Vol. II



j6880ph1.jpg

IFC-3030 shown in CAB-C4 backbox with 640-character display

Features

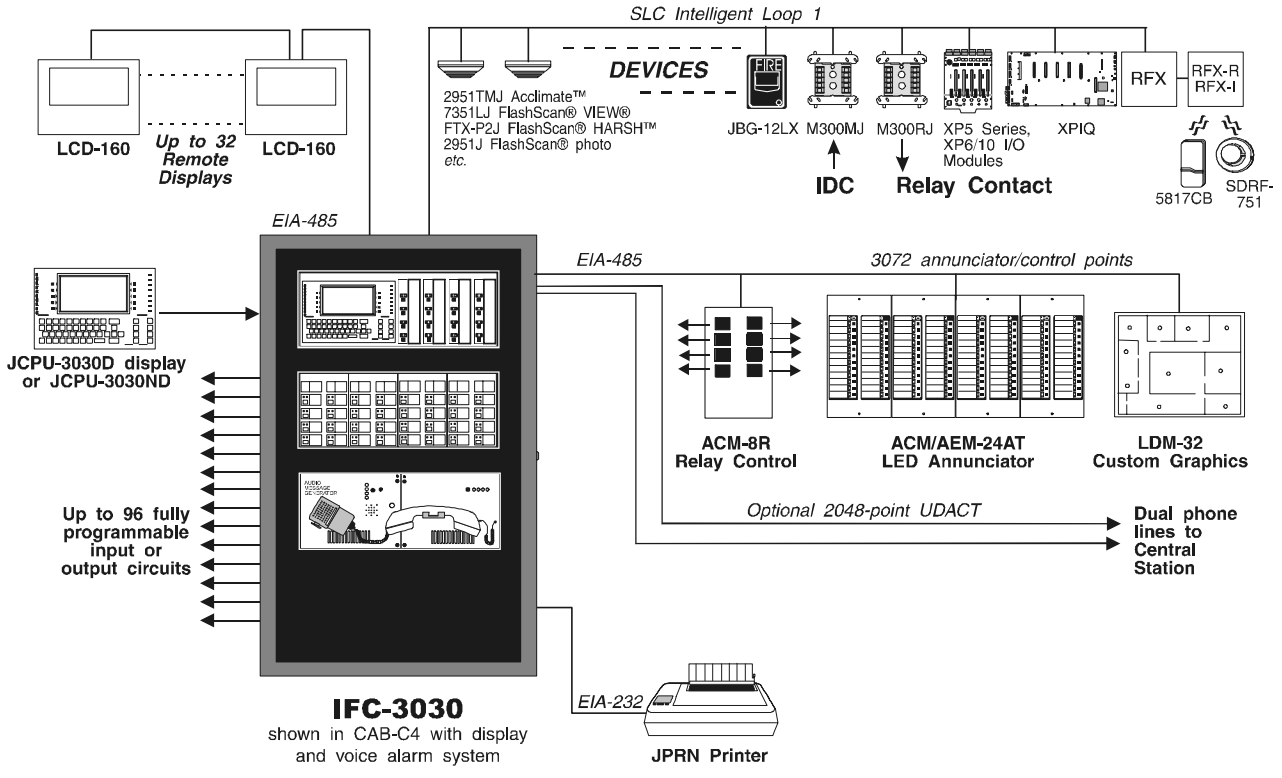
- One to ten isolated intelligent Signaling Line Circuits (SLC) Style 4, 6 or 7.
- Up to 159 detectors (any mix of ion, photo, laser photo, thermal, or multi-sensor) and 159 modules (N.O. manual stations, two-wire smoke, notification, or relay) per SLC. 318 devices per loop/3180 per FACP or network node.
- Large 640-character LCD backlit display (16 lines x 40 characters) or display-less (a node on a network).
- Network option – supports IFC-640, IFC-3030, JNCA network annunciator, or IFW network control station.
- UniNet® compatible.
- Built-in Alarm, Trouble, Security, and Supervisory relays.
- Up to 96 input or output panel circuits per FACP or network node; circuits configurable online.
- ***VeriFire™ Tools*** online/offline program option.
- Application code is saved in Flash memory, eliminating the need to change EPROMs.
- Built-in Degraded Mode option. In the event of a CPU failure, the system is capable of general alarm if a fire condition is present.
- Weekly Occupancy Schedules allow changing sensitivity by time of day and day of week.
- Optional universal 2040-point DACT.
- EIA-485 annunciators, including custom graphics.
- Printer interface (80-column and 40-column printers).
- History file with 4000-event capacity in nonvolatile memory, plus separate 1000-event alarm-only file.
- Advanced history filters allow sorting by event, time, date, or address.
- Alarm Verification selection per point, with tally.
- Autoprogramming and Walk Test reports.
- Positive Alarm Sequence (PAS) Presignal.
- Silence inhibit and Auto Silence timer options.
- March time and temporal signals supported on panel circuits.
- Field-programmable on panel or on PC, with ***VeriFire™ Tools*** program, also check, compare.
- Non-alarm points for lower priority functions.
- Remote ACK/Signal Silence/System Reset/Drill via monitor modules.
- Powerful Boolean logic equations — 1000!
- Supports SCS Series smoke control system in both HVAC or FSCS modes.

JOHNSON CONTROLS
For more information, contact your
Johnson Controls Field Support Center.
507 East Michigan Street, Milwaukee, WI 53202

Made in the U.S.A.

- EIA-232 printer port.
- EIA-485 annunciator port.
- **640-character display features:**
  - ✔ *Backlit, 640-character display.*
  - ✔ *Program keypad: full QWERTY keypad.*
  - ✔ *Up to nine users, each with a password and selectable access levels.*
  - ✔ ***10 LED indicators:** Power; Fire Alarm; Pre-Alarm; Security; Supervisory; System Trouble; Other Event; Signals Silenced; Point Disabled; CPU Failure.*
  - ✔ ***Membrane Switch Controls:** Acknowledge; Signal Silence; Drill; System Reset; Lamp Test.*
  - ✔ ***LCD Display:** 640 characters (16 x 40) with long-life LED backlight.*
- **FlashScan® intelligent features:**
  - ✔ *Poll 318 devices on each loop in less than two seconds.*
  - ✔ *Activate up to 159 outputs in less than five seconds.*
  - ✔ *Multicolor LEDs blink device address during Walk Test.*
  - ✔ *Fully digital, high-precision protocol (U.S. Patent 5,539,389).*
  - ✔ *Manual sensitivity adjustment — nine levels.*
  - ✔ *Pre-alarm AWACS™ — nine levels.*
  - ✔ *Sensitivity windows:*
    ***Ion** – 0.5 to 2.5%/foot obscuration.*
    ***Photo** – 0.5 to 2.35%/foot obscuration.*
    ***Laser (VIEW®)** – 0.02 to 2.0%/foot obscuration.*
    ***Acclimate™** – 0.5 to 4.0%/foot obscuration.*
    ***HARSH™** – 0.5 to 2.35%/foot obscuration.*
  - ✔ *Drift compensation (U.S. Patent 5,764,142).*
  - ✔ *Multi-detector algorithm involves nearby detectors in alarm decision (U.S. Patent 5,627,515).*
  - ✔ *Automatic detector sensitivity testing.*
  - ✔ *Maintenance alert (two levels).*
  - ✔ *Self-optimizing pre-alarm.*
  - ✔ *Programmable activation of sounder/relay bases during alarm or pre-alarm.*
  - ✔ *Read Status displays the level of detector cleanliness.*
- **VIEW® Very Intelligent Early Warning smoke detection technology:**
  - ✔ *Revolutionary spot laser design.*
  - ✔ *Advanced AWACS™ algorithms differentiate between smoke and non-smoke signals (U.S. Patent 5,831,524).*
  - ✔ *Addressable operation pinpoints the fire location.*
  - ✔ *No moving parts to fail or filters to change.*
  - ✔ *Early warning performance comparable to the best aspiration systems at a fraction of the lifetime cost.*
- **Acclimate™ low-profile intelligent multi-sensor:**
  - ✔ *Detector automatically adjusts sensitivity levels without operator intervention or programming. Sensitivity increases with heat.*
  - ✔ *Microprocessor-based technology; combination photo and thermal technology.*
  - ✔ *Low-temperature signal at 40°F ± 5°F (4.44°C ± 2.77°C).*
- **RFX Wireless Interface System:**
  - ✔ *Allows protection in areas where the use of wire is uneconomical or unpractical.*
  - ✔ *Allows communication with wireless smoke detectors and wireless monitor modules; each RFX unit and detector is assigned an address.*
  - ✔ *Requires 24 VDC from SLC or system auxiliary power.*
- **HARSH™ Hostile-Area Smoke Head:**
  - ✔ *Provides early warning of smoke detection in environment where traditional smoke detectors are not practical.*
  - ✔ *The detector's filters remove particulates down to 30 microns in size.*
  - ✔ *Intake fan draws air into photo chamber, while airborne particles and water mist are removed.*
  - ✔ *Requires auxiliary 24 VDC from SLC or system auxiliary power.*

Sample System Options



j6880blk.wmf

- **Releasing features:**
  - ✔ *Ten independent hazards.*
  - ✔ *Sophisticated cross-zone (three options).*
  - ✔ *Delay timer and Discharge timers (adjustable).*
  - ✔ *Abort (four options).*
- **Voice and telephone features:**
  - ✔ *Solid state message generation.*
  - ✔ *Hard-wired voice control module options.*
  - ✔ *Firefighter telephone option.*
  - ✔ *30- to 120-watt high-efficiency amplifiers (AA Series).*
  - ✔ *Backup tone generator and amplifier option.*
  - ✔ *Multichannel voice transponder (XPIQ).*

FlashScan® Exclusive New World-Leading Detector Protocol

At the heart of the IFC-3030 is a set of detection devices and device protocol — FlashScan® (U.S. Patent 5,539,389). FlashScan® is an all-digital protocol that gives superior precision and high noise immunity.

As well as giving quick identification of an active input device, this new protocol can also activate many output devices in a fraction of the time required by competitive protocols. This high speed also allows the IFC-3030 to have the largest device per loop capacity in the industry — 318 points — yet every input and output device is sampled in less than two seconds. The microprocessor-based FlashScan® detectors have bicolor LEDs that can be coded to provide diagnostic information, such as device address during Walk Test.

AWACS™ Advanced Warning Addressable Combustion Sensing

AWACS™ is a set of software algorithms that provide the IFC-3030 with industry-leading smoke detection capability. These complex algorithms require many calculations on each reading of each detector, and are made possible by the very high-speed microcomputer used by the IFC-3030.

Drift Compensation and Smoothing. Drift compensation allows the detector to retain its original ability to detect actual smoke, and resist false alarms, even as dirt accumulates. It reduces maintenance requirements by allowing the system to automatically perform the periodic sensitivity measurements required by NFPA Code 72. Smoothing filters are also provided by software to remove transient noise signals, usually caused by electrical interference.

Maintenance Warnings. When the drift compensation performed for a detector reaches a certain level, the performance of the detector may be compromised, and special warnings are given. There are three warning levels: (1) Low Chamber value, usually indicative of a hardware problem in the detector; (2) Maintenance Alert, indicative of dust accumulation that is near but below the allowed limit; (3) Maintenance Urgent, indicative of dust accumulation above the allowed limit.

Sensitivity Adjust. Nine sensitivity levels are provided for alarm detection. These levels can be set manually, or can change automatically between day and night. Nine levels of pre-alarm sensitivity can also be selected, based on predetermined levels of alarm. Pre-alarm operation can be latching or self-restoring, and can be used to activate special control functions.

Self-Optimizing Pre-Alarm. Each detector may be set for "Self-Optimizing" pre-alarm. In this special mode, the detector "learns" its normal environment, measuring the peak analog readings over a long period of time, and setting the pre-alarm level just above these normal peaks.

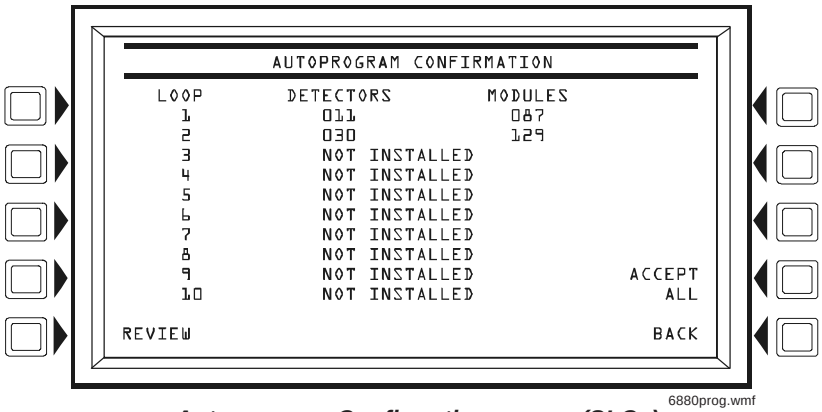
Cooperating Multi-Detector Sensing. A patented feature of AWACS™ is the ability of a smoke sensor to consider readings from nearby sensors in making alarm or pre-alarm decisions. Without statistical sacrifice in the ability to resist false alarms, it allows a sensor to increase its sensitivity to actual smoke by a factor of almost two to one.

Field Programming Options

Autoprogram is a timesaving feature of the IFC-3030. It is a special software routine that allows the IFC-3030 to "learn" what devices are physically connected and automatically load them in the program with default values for all parameters. Requiring less than one minute to run, this routine allows the user to have almost immediate fire protection in a new installation, even if only a portion of the detectors are installed.

Keypad Program Edit. The IFC-3030 has the exclusive feature of program creation and editing capability from the front panel keypad, ***while continuing to provide fire protection.*** The architecture of the IFC-3030 software is such that each point entry carries its own program, including control-by-event links to other points. This allows the program to be entered with independent per-point segments, while the IFC-3030 simultaneously monitors other (already installed) points for alarm conditions.

VeriFire™ Tools is an offline programming and test utility that can greatly reduce installation programming time, and increase confidence in the site-specific software. It is Windows® based and provides technologically advanced capabilities to aid the installer. The installer may create the entire program for the IFC-3030 in the comfort of the office, test it, store a backup file, then bring it to the site and download from a laptop into the panel.



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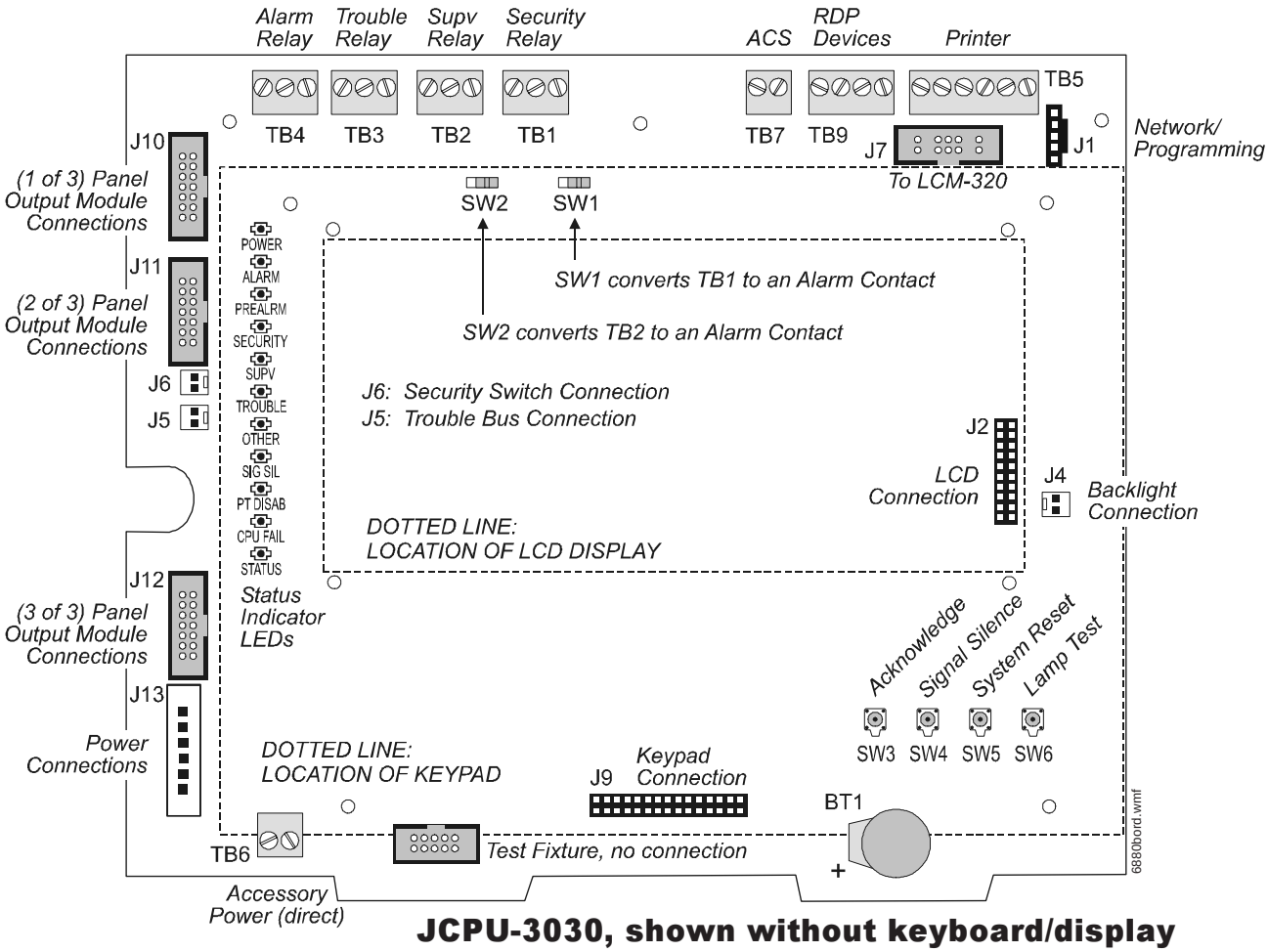
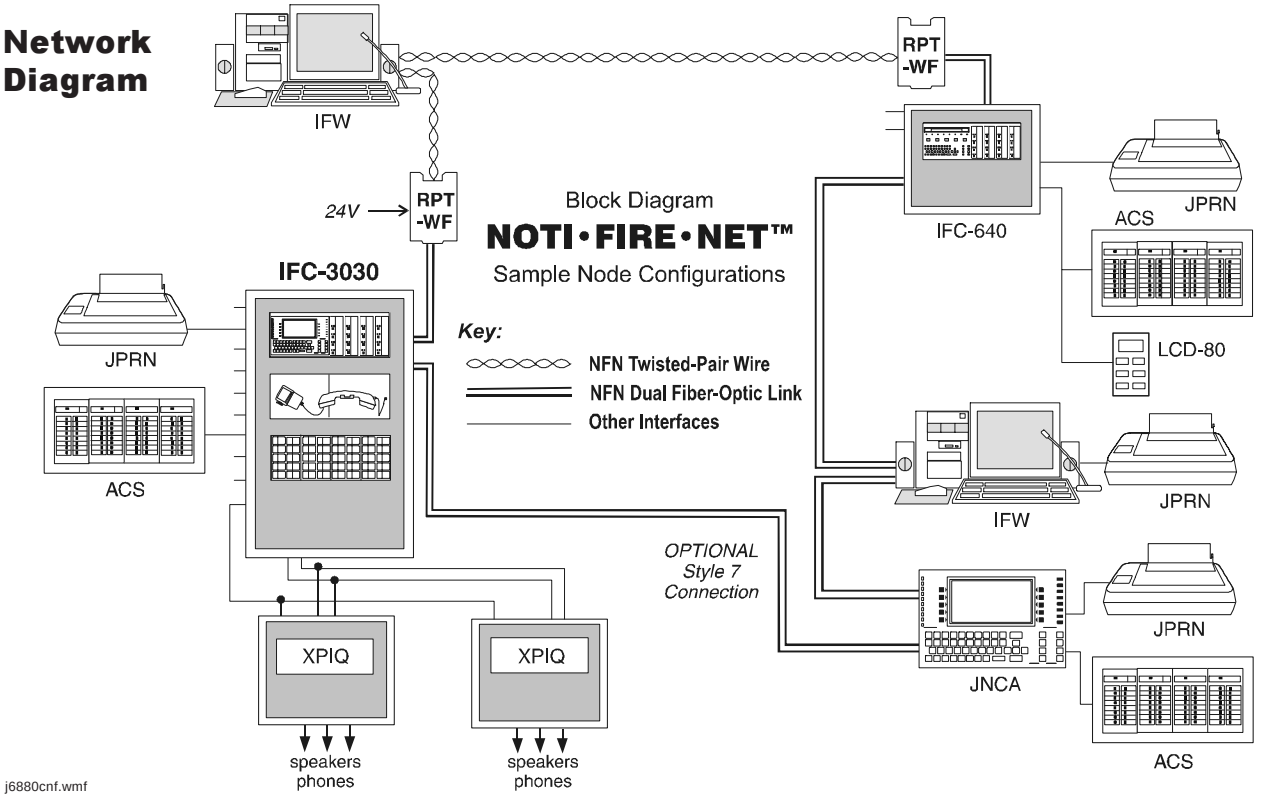
Autoprogram Confirmation screen (SLCs)



JCPU-3030, shown without keyboard/display

The control panel electronics are contained on one printed circuit board (PCB) that holds the central processing unit (JCPU-3030). The JCPU-3030 can be purchased with or without keypad and display; connections are identical on both versions. Diagram shows location of connections, switches, jumpers, and LEDs on the circuit board.

Network Diagram



Placement of Equipment in Chassis and Cabinet

The following guidelines outline the IFC-3030's flexible system design.

Rows: The first row of equipment in the cabinet mounts in chassis **CHS-M3**. Mount the second, third, or fourth rows of equipment in chassis **CHS-4MB** (see *IFC-3030 Installation Manual* regarding panel output modules) or **CHS-4L** (for voice components, see *Voice Alarm System Manual*).

Wiring: When designing the cabinet layout, consider separation of power-limited and non-power-limited wiring as discussed in the *IFC-3030 Installation Manual*.

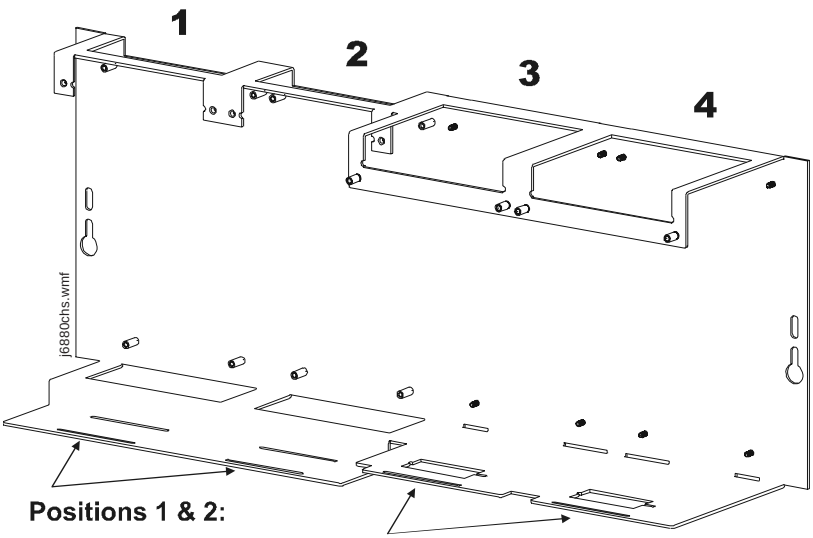
Positions: A chassis offers four basic side-by-side positions for components; the number of modules that can be mounted in each position depends on the chassis model and the size of the individual module. There are a variety of standoffs and hardware items available for different combinations and configurations of components.

CAUTION!

It is critical that all mounting holes of the IFC-3030 are secured with a screw or standoff to ensure continuity of Earth Ground.

Layers: The JCPU-3030 mounts in chassis CHS-M3 in the top row of the cabinet. The JCPU-3030 and its optional display occupy the left half of the chassis (positions 1 and 2). If JNCA is used, it may be door-mounted in front of a displayless JCPU-3030ND. The right half (positions 3 and 4) of CHS-M3 can hold up to four layers of equipment including annunciators, panel output modules, and option boards. The BMP-1 Blank Module Plate covers unused positions and also provides a location to door-mount some option boards. Second, third, and fourth tiers of equipment use any chassis compatible with CAB-4 Series backboxes, such as the CHS-4MB. Some equipment, such as the JNCA and annunciators, can be door-mounted; refer to equipment documentation for details.

Expansion: Loop Control Module LCM-320 adds SLC loops to the IFC-3030; the Loop Expander Module LEM-320 expands an LCM-320; adding another loop. The IFC-3030 supports up to five LCMs and up to five LEMs. Other option boards include the NCM-W, NCM-F, and the TM-4. Panel modules include CRM-4RK, DCM-4RK, ICM-4RK, IZE-A, IZM-8RK, VCM-4RK, and their respective expanders.



Agency Listings and Approvals

See the first page of this data sheet for listing agencies and file numbers. These listings and approvals apply to the basic IFC-3030 control panel. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

The IFC-3030 complies with UL Standards 864 (Fire) and 1076 (Burglary). It is designed to meet NFPA 72 Local, Auxiliary, Remote Station, Proprietary, and Emergency Voice/Alarm Fire System Requirements.

Specifications

- Primary input power, ***AMPS-24:*** 120 VAC, 50/60 Hz, 3.0 amps. ***AMPS-24E:*** 220/240 VAC, 50/60 Hz, 1.5 Amps.
- ***Total*** output 24 V power: 4.5 A in alarm.*
- General purpose power: 1.0 A.
- Battery charger range: 25 AH – 200 AH. Use separate cabinet for batteries over 25 AH.
- Float Rate: 27.6 V.
- Temperature and humidity ranges: This system meets NFPA requirements for operation at 0°C to 49°C (32°F to 120°F); and at a relative humidity (noncondensing) of 85% at 30°C (86°F) per NFPA, and 93% ± 2% at 32°C ± 2°C (89.6°F ± 1.1°F) per ULC. However, the useful life of the system's standby batteries and the electronic components may be adversely affected by extreme temperature ranges and humidity. Therefore, it is recommended that this system and all peripherals be installed in an environment with a nominal room temperature of 15°C to 27°C (60°F to 80°F).

Note: *The power supply has a total of 4.5 Amps of available power.*

System Capacity

- Intelligent Signaling Line Circuits ..... 1 expandable to 10
- Intelligent detectors ..... 159 per loop
- Addressable monitor/control modules ..... 159 per loop
- Programmable input and output panel circuits 96
- Programmable software zones ..... over 2000
- ACS annunciators per JCPU-3030 ..... 32 address x 64 or 96* points

***Note:** The JCPU-3030 can support up to 96 annunciator address points per ACM-24AT/-48A.*

PRODUCT LINE INFORMATION

- *Configuration Guidelines*
- *Network Options*
- *Power Supplies*
- *System Modules*
- *Audio Options*
- *Compatible Devices, EIA-232 Ports*
- *Compatible Devices, EIA-485 Ports*
- *Compatible Intelligent Devices*
- *Other Options*

Configuration Guidelines

Stand-alone and network systems require a main display. On single-CPU systems (one IFC-3030), the display option is the JCPU-3030D. On network systems (two or more IFC-3030s and/or IFC-640s), at least one JNCA or IFW annunciation device is required. Options listed as follows:

JCPU-3030D: IFC-3030 Primary Display. JCPU-3030D ships with keypad/display installed; includes 640-character backlit LCD display, QWERTY programming and control keypad. **JCPU-3030** is a central processing unit and requires an **AMPS-24(E)** power supply.

JCPU-3030ND: JCPU-3030 without display.

JVeriFire-TCD: ***VeriFire™ Tools*** CD-ROM. Contains programming software for the IFC-3030, IFC-640, JNCA, and XPIQ. Includes local panel connection cable. *Programming PC requires a serial port connection.* ***See VeriFire™ Tools technical bulletin.***

LCM-320: Loop Control Module. Adds SLCs to 3030; 3030 supports up to 5 LCM-320s and 5 LEM-320s. ***See LCM/LEM-320 technical bulletin.***

LEM-320: Loop Expander Module. Expands each LCM used on the 3030. ***See LCM/LEM-320 technical bulletin.***

CHS-M3: Mounting chassis for JCPU-3030. *One required for each JCPU-3030D/3030ND.*

DP-DISP: Dress panel for top row in cabinet with JCPU-3030D installed.

BMP-1: Blank module for unused module positions.

Sample system: *Four-loop IFC-3030 with display: JCPU-3030D, DP-DISP, two BMP-1s, CHS-M3, two LCM-320s, two LEM-320s, AMPS-24, SBB-A4, JDR-A4, BP-4, BB-100, and batteries.*

Network Options

JNCA: Network Control Annunciator, 640 characters. An alternate primary display for JCPU-3030 can be provided by the JNCA or the IFW. Using JNCA as primary display enables non-English languages. When used on single JCPU-3030 systems, the JNCA is the Primary Display for the panel and connects directly to the JCPU-3030. On network systems (two or more JCPU-3030s), one network display (either JNCA or IFW) is required for every system. On network systems, the JNCA connects (and requires) an NCM network communications module. Mounts in a row of FACP node or in two annunciator positions. Mounting options include the DP-DISP, ADP-4B, or in an annunciator box, such as the JABS-2D. In CAB-4 top-row applications, a DP-DISP and two BMP-1 blank modules are required for mounting. ***See JNCA technical bulletin.***

NCM-W: Network Communications Module, Wire. Order one NCM per network node (JCPU-3030 or JNCA). ***See NCM technical bulletin.***

NCM-F: Network Communications Module, Fiber. Order one NCM per network node (JCPU-3030 or JNCA). ***See NCM technical bulletin.***

RPT-W: repeater board; wire connection.

RPT-F: repeater board; fiber connection.

RPT-WF: repeater board; allows a change in media type between wire and fiber.

IFW-W: Intelligent Fire Workstation (network control station), Wire. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each IFW consumes one of 103 network addresses. ***See IFW technical bulletin.***

IFW-F: Intelligent Fire Workstation (network control station), Fiber. UL-Listed graphics PC with mouse, 17" color flat-screen LCD monitor. Order as necessary for network systems. Each IFW consumes one of 103 network addresses. ***See IFW technical bulletin.***

Power Supplies

AMPS-24(E): *One required for each IFC-3030.* Addressable power supply and battery charger with two 24 VDC outputs. Addressable by any FlashScan® or CLIP mode FACP. Charges 25 to 200 AH batteries. Occupies up to four addresses on an SLC, depending on configuration. Primary input power for panel; ***AMPS-24:*** 110-120 VAC, 50/60 Hz, 4.5 A maximum. ***AMPS-24E:*** 220/240 VAC, 50/60 Hz, 2.25 A maximum. ***See AMPS-24 technical bulletin.***

BB-100: Battery and power supply backbox. The BB-100 mounts the AMPS-24(E) power supply (when the main power supply does not mount in the main cabinet). It also mounts up to two PS/BAT-121000 100-AH batteries. 30" (76.20 cm) wide x 25" (63.50 cm) high x 7.5" (19.05 cm) deep; depth includes door.

BB-200: Battery and power supply backbox. The BB-200 mounts the AMPS-24(E) power supply (when the main power supply does not mount in the main cabinet). It also mounts up to four PS/BAT-121000 100-AH batteries. 30" (76.20 cm) wide x 36" (91.44 cm) high x 7.5" (19.05 cm) deep; depth includes door.

NFS-LBB: Battery Box *(required for batteries over 25 AH)*. *Dimensions: Box:* 24" (610 mm) wide x 14" (356 mm) high x 7.75" (197 mm) deep. *Door:* 24.125" (613 mm) wide x 14.25" (362 mm) high; door adds 0.0625" (approx. 1.6 mm) to depth.

APS-6R: Auxiliary Power Supply (expander). Provides up to 6.0 amperes of regulated power for compatible Notification appliance circuits. Includes battery input and transfer relay, and overcurrent protection. Mounts on one of four positions on a CHS-4L or CHS-4 chassis.

ACPS-2406: six-amp addressable charger power supply. ***See ACPS-2406 technical bulletin.***

FCPS-24: The FCPS-24 is a remote six-amp (four-amp continuous) repeater/power supply.

FCPS-24S6/-24S8: Remote six-amp and eight-amp power supplies with battery charger. ***See FCPS-24S6/-24S8 technical bulletin.***

BAT Series: IFC-3030 utilizes two 12 volt, 12 to 55 AH batteries.

PS Series: IFC-3030 utilizes two 12 volt, 25 to 200 AH batteries.

System Modules

The IFC-3030 includes the ability to communicate with up to twelve conventional modules each with up to eight circuits. Any mix of initiating, notification, relay, speaker, or telephone may be used. Choose any combination of up to eight input (IZM/IZE) or output modules: ICM/ICE, CRM/CRE, DCM or VCM/VCE. Panel modules mount on either: the two far-right positions of the ***CHS-M3*** *(next to the primary display); or on any of the four positions on the* ***CHS-4N*** *chassis (****CHS-4MN*** *kit required).* ***NOTES: 1) These modules/expanders are NOT to be used for releasing applications. 2) For additional information on these panel circuit modules and expanders, see Panel Circuit Modules technical bulletin.***

CHS-4MB: Expansion Chassis. Mounts up to four modules. Includes **CHS-4N**, **MP-1B** (Module Dress Panel), and **Expander Ribbon Cable**.

IZM-8RK and IZE-A: The IZM-8RK includes eight Class B (Style B) Initiating Zones (Initiating Device Circuits) that can be selected for Class A/B with the addition of an IZE-A expander module. Each IZM/IZE zone can be programmed for a

variety of initiating devices functions including: dry contact input, two-wire smoke detection, flow, tamper, non-fire, and many others. The IZM-8RK (with optional IZE-A) mounts in one of four possible positions on the CHS-4N mounting chassis. IZE-A Initiating Zone Expander; when used with IZM-8RK, provides eight Style D (Class A) alarm initiating circuits.

ICM-4RK: Notification Appliance Circuit Module, provides four Style Y (Class B) or Style Z (Class A) alarm Notification Appliance Circuits. Maximum signaling current is 3.0 amps per circuit or 6.0 amps per module, subject to power supply limitations (includes auxiliary power harness, ELRs and slide-in labels). Includes ON/OFF controls and ON/OFF LEDs.

ICE-4: Notification Appliance Circuit Expander, expands ICM-4 to provide a total of eight Style Y or Style Z alarm Notification Appliance Circuits. Circuit ratings are same as ICM-4. ***Note:*** *maximum of one per ICM-4RK.* May also be used to add four Notification Appliance Circuits to VCM-4.

CRM-4RK: Control Relay Module, four Form-C relay contacts, rated at 5.0 A, 120 VAC or 28 VDC (resistive) per circuit. Includes manual ON/OFF controls and LEDs.

CRE-4: Control Relay Expander, expands CRM-4 to provide a total of eight Form-C relay contacts. ***Note:*** *maximum of one per CRM-4RK.* May also be connected to add four relays to ICM-4 or VCM-4.

VCM-4RK: Voice Control Module provides four Style Y (25 and 70 VRMS) and Style Z (25 VRMS only) speaker circuits, eight manual select switches and indicators, slide-in labels, and plug-in terminal blocks. Move jumper to convert to telephone circuits with remote ring signal and local call-in flash. May be expanded to eight circuits with VCE-4, ICE-4, or CRE-4.

VCE-4: Voice Control Expander adds four circuits to VCM-4. ***Note:*** *VCM-4/ VCE-4 combination must be eight speaker or eight phone circuits.*

DCM-4RK: Dual Channel Module provides four Class B (Style Y, 25 and 70 VRMS) or Class A (Style Z, 25 VRMS only) speaker circuits plus four channel A/B select relays. Not expandable.

ARM-4: Auxiliary Relay Module, four Form-C relays controlled by a relay module (CRM-4 or CRE-4). N.O. contacts rated 20 amps; N.C. contacts rated 10 amps at 125 VAC and 30 VDC. ***Note:*** *maximum of one for each CRM-4 or CRE-4.*

Audio Options

JVCC-1B: Voice Control Center. Provides a variety of user-selectable tones on a single channel. Up to two different tones or messages may be selected on a single channel. Also provides optional digital voice message capability and ***on-site*** programmable voice messages. Includes Audio Message Generator (**AMG-1**) microphone, cables, dress panels, and instructions.

JVTCC-1B: Voice/Telephone Control Center. Provides all that the JVCC-1(B) provides plus two-way Fire Fighters Telephone (**FFT-7**) capability.

JTCC-1B: Telephone Control Center. Provides a stand-alone two-way Fire Fighters telephone (**FFT-7S**). Includes cables, dress panel and instructions.

AMG-E: Audio Message Generator (without microphone). Order in addition to JVCC-1(B) or JVTCC-1(B) if two-channel system is required.

FFT-7/FFT-7S: Fire Fighters Telephone control with master handset.

FTM-1: Firephone Control Module connects a remote firefighter telephone to a centralized telephone console. Reports status to panel. Wiring to jacks and handsets is supervised.

RM-1/RM-1SA: Remote microphone assemblies, mount on ADP-4 (RM-1) dress panel or CAB-RM/-RMR (RM-1SA) stand-alone cabinets.

AA-30: Audio Amplifier, 30 watts. Switch-mode power. Includes amplifier and audio input supervision, backup input, and automatic switchover, power supply, cables.

AA-120/AA-100: Audio Amplifier provides up to 120 watts of 25 VRMS audio power. The amplifier contains an integral chassis for mounting to a CAB-B4, -C4, or -D4 backbox (consumes one row). Switch-mode power. Includes audio input and amplified output supervision, backup input, and automatic switchover to backup tone. Order the AA-100 for 70.7 VRMS systems and 100 watts of power.

VROM-(n): Factory-programmed message for installation in AMG-1. Provides up to 24 seconds of evacuation message on nonvolatile memory chip. Choose one of many standard messages available. Up to two of these messages may be installed in one AMG. Includes VROM, instructions for installation and operation, and written text of message.

VRAM-1: Field-programmed memory to be installed in AMG-1. Provides up to 24 seconds of field-programmable evacuation message on nonvolatile memory chip. Message is programmed from microphone or cassette tape. Up to two of these nonvolatile memory chips may be installed in one AMG. Includes VRAM and instructions for installation and operation.

XP Series: The XP Series Transponder provides conventional monitor and control points (CLIP mode only).

XPIQ: The XPIQ quad intelligent voice transponder for distributed multichannel voice evacuation systems, an integrated audio amplification and distribution subsystem controlled by FACP. Capable of playing up to four simultaneous messages. Accepts up to four 25-watt amplifiers.

Compatible Devices, EIA-232 Ports

JPRN-5: 80-column printer. ***See JPRN-5 technical bulletin.***

JPRN-6: 80-column printer. ***See JPRN-6 technical bulletin.***

VS4095/S2: Printer, 40-column, 24 V. ***Order from Keltron, Inc.***

Compatible Devices, EIA-485 Ports

ACS Series: Annunciator Control Modules **ACM-16AT**, **AEM-16AT**, **ACM-32A**, and **AEM-32A**.

ACM-24AT: ACS Series annunciator for IFC-640 and IFC-3030 – up to 96 points of annunciation with Alarm or Active LED, Trouble LED, and switch per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) by point to be red, green, or yellow; the Trouble LED is always yellow. ***See ACS Series Annunciator technical bulletin.***

AEM-24AT: Same LED and switch capabilities as ACM-24AT, expands the ACM-24AT to 48, 72, or 96 points. ***See ACS Series Annunciator technical bulletin.***

ACM-48A: ACS Series annunciator for IFC-640 and IFC-3030 – up to 96 points of annunciation with Alarm or Active LED per circuit. Active/Alarm LEDs can be programmed (by powered-up switch selection) in groups of 24 to be red, green, or yellow. Expandable to 96 points with one AEM-48A. ***See ACS Series Annunciator technical bulletin.***

AEM-48A: Same LED capabilities as ACM-48A, expands the ACM-48A to 96 points. ***See ACS Series Annunciator technical bulletin.***

ACM-8R: Remote Relay Module with eight Form-C contacts. Can be located up to 6,000 ft. (1828.8 m) from panel on four wires.

LCD-80: Liquid Crystal Display annunciator, 80-characters backlit. Use in ACS mode only. ***See LCD-80 technical bulletin.***

LCD-160: Liquid Crystal Display annunciator, 160-character backlit. Can store character sets for multiple languages. Supports Canadian requirements.

LDM Series: Lamp Driver Modules **LDM-32**, **LDM-E32**, and **LDM-R32**.

RFX: Wireless interface system. ***See RFX technical bulletin.***

RPT-485 Series: Repeats EIA-485 over twisted pair or converts to fiber-optic medium; repeater, isolator and/or fiber-optic modem.

SCS Series: Smoke control station; eight (expandable to 16) circuits.

TM-4: Transmitter Module. Includes three reverse-polarity circuits and one municipal box circuit. Mounts in panel module position (as in single-address mode applications) or in CHS-M3 position. ***See TM-4 technical bulletin.***

UDACT: Universal Digital Alarm Communicator Transmitter, 636 channel.

UZC-256: Programmable Universal Zone Coder provides positive non-interfering successive zone coding. Microprocessor-controlled, field-programmable from IBM®-compatible PCs *(requires optional programming kit)*.

Compatible Intelligent Devices

1951J: Low-profile FlashScan® ionization detector, will replace 1351J.

1351J: Low-profile FlashScan® ionization detector.

2951J: Low-profile FlashScan® photoelectric detector, will replace 2351J.

2351J: Low-profile FlashScan® photoelectric detector.

2951TJ: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal, will replace 2351TJ.

2351TJ: Low-profile FlashScan® photoelectric detector with 135°F (57°C) thermal.

5951J: FlashScan® thermal detector 135°F (57°C), will replace 5351J.

5351J: FlashScan® thermal detector 135°F (57°C).

5951RJ: FlashScan® thermal detector 135°F (57°C) with rate-of-rise, will replace 5351RJ.

5351RJ: FlashScan® thermal detector 135°F (57°C) with rate-of-rise.

5951HJ: FlashScan® 190°F (88°C) high-temperature thermal detector.

DH300P: FlashScan® photo duct detector with housing.

DH300PL: *Low-flow* FlashScan® photo duct detector with housing, will replace DH300P.

DH300RP: FlashScan® photo duct detector with relay and housing.

DH300RPL: *Low-flow* FlashScan® photo duct detector with relay and housing, will replace DH300RP.

2951TMJ: FlashScan Acclimate™ low-profile multisensor detector, will replace 2351TMJ.

2351TMJ: Acclimate™ low-profile multisensor detector.

FTX-P2J: FlashScan® HARSH™ Hostile Area Smoke Head.

FTX-P1J: HARSH™ Hostile Area Smoke Head, CLIP only.

7351LJ: FlashScan® VIEW® laser photo detector.

7251J: Low-profile VIEW® laser photo detector, CLIP only.

B224RB: Low-profile relay base.

B224BI: Isolator base for low-profile detectors.

B210LPJ: Low-profile base. Standard U.S. style.

B501J: European-style, 4" (10.16 cm) base.

B710HD: Base for FTX-P2J HARSH™ detector above.

M300MJ: FlashScan® monitor module.

M300DJ: FlashScan® dual monitor module.

M302MJ: FlashScan® two-wire detector monitor module.

M301MJ: FlashScan® miniature monitor module.

M300CJ: FlashScan® NAC control module.

M300RJ: FlashScan® relay module.

M300SMJ: FlashScan® pull station monitor module.

JBG-12LX: Manual fire alarm station, addressable.

M500XJ: Isolator module.

XP Series: Transponders, provide conventional monitor and control points (CLIP mode only).

XP5-M: FlashScan® transponder, five monitor points.

XP5-C: FlashScan® transponder, five control points or Form-C relays.

XP6-C: Six-supervised control module; monitors wiring to devices that require external power supply to operate.

XP6-MA: Six-zone module for interface between intelligent alarm system and a two-wire conventional detection zone.

XP6-R: Six (Form-C)-relay control module.

XP10-M: Ten-input monitor module; interface between a control panel and normally-open contact devices.

XPIQ: Intelligent quad transponder.

Other Options

DPI-232: Direct Panel Interface, specialized modem for extending serial data links to remotely located FACPs and/or peripherals.

CHS-4N: Chassis for mounting up to four APS-6Rs.

CHS-4L: Low-profile four-position Chassis. Mounts two AA-30 amplifiers or one AMG-E and one AA-30.

DP-1B: Blank Dress panel. Provides dead-front panel for unused tiers or to cover AA-30, AA-120, or AMG-E.

CAB-4 Series: The CAB-4 Series cabinets are fabricated from 16-gauge steel with unique full-front LEXAN®, reverse-silk-screened for durability. The cabinet assembly consists of two basic parts: a Backbox (SBB-_4), and a Locking Door (JDR-_4) that may hinge right or left. Cabinets are available in four sizes, “A” through “D”, with one to four tiers. A trim ring option is available for semi-flush mounting.

Other options as listed in previous sections. Technical bulletins are available for many of these products.

FEDERAL SIGNAL CORPORATION

SelecTone® Supervised Command Unit

Model 300SSC

DESIGNED FOR INDUSTRIAL EMERGENCY EVACUATION

- Ideal for general multiple tone signaling
- Flexible, expandable system provides local and remote voice communication
- Available in 120VAC with 24VDC backup capability
- Wall mount
- UL Listed, CSA Approved
- Meets NFPA and OSHA requirements
- NEMA Type 1, IP40 enclosure

Federal Signal's Model 300SSC Supervised SelecTone® Command Unit is the heart of a fully supervised plant and employee protection signaling system for industry. A rugged steel enclosure and locking door with a plexi-glass window protects the hand-held microphone and local control switches from unauthorized access.

This unit includes both a visual and audible annunciator system that alerts the user to any alarm or trouble conditions. All initiating and signal lines, control circuitry, and switches are supervised. Up to four distinct audible warning signals including voice can be broadcast the speaker/amplifier units in a SelecTone system.

Messages are prioritized with the highest priority assigned to the local microphone, followed by tones 1-4, and lastly the auxiliary PA. If a given tone is sounding while a higher priority tone is locally or remotely activated, the higher priority tone automatically takes precedence.

Two built-in auxiliary relay circuits are programmable to meet specific user needs for controlling door locks, fire doors, fan circuits or other process control functions. Circuitry is provided to activate the local municipal box.

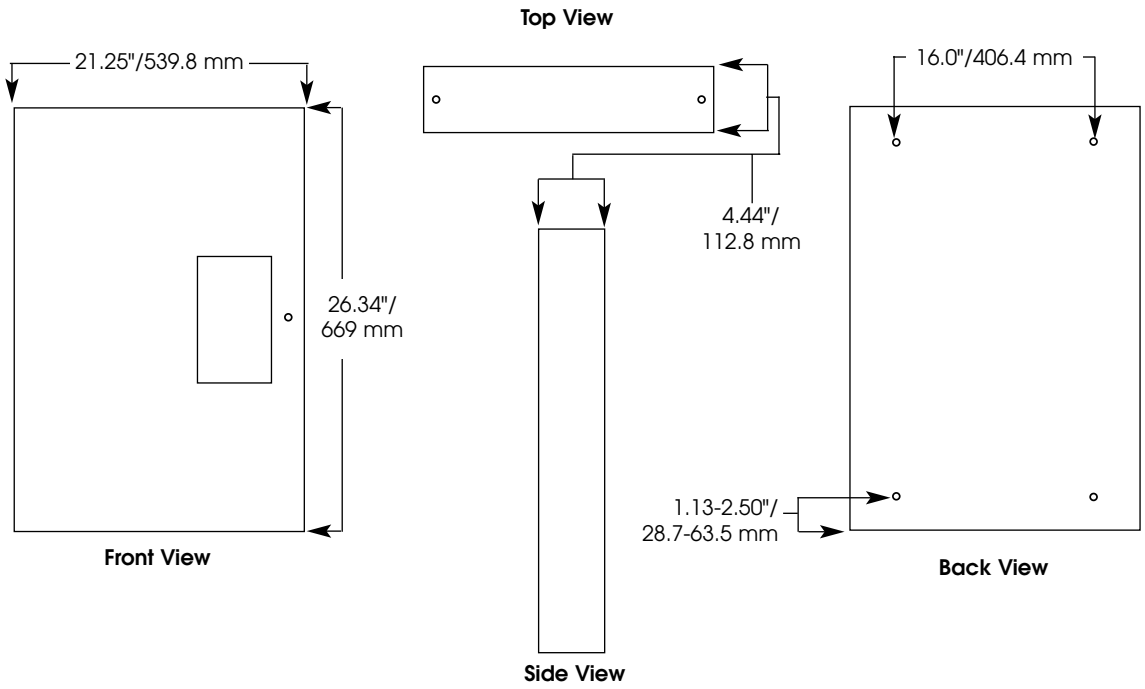
The fully annunciated control panel provides easy control and analysis of system condition. Tone signals can be tested on a monitor speaker without sounding false alarms or activating peripheral equipment.

The Federal Signal Supervised SelecTone Command Unit is designed for employee evacuation and provides automatic indication of system trouble.

Model	Voltage	Operating Current	Sys. Standby Current
300SSC	24VDC*	1.24 amps	0.13 amps
300SSC	120VAC 50/60Hz	0.48 amps	0.13 amps

*With emergency power input.

SELECTONE® SUPERVISED COMMAND UNIT (300SSC)



SPECIFICATIONS

Net Weight:	43.0 lbs.	20 kg
Shipping Weight:	48.2 lbs.	22 kg
Height:	26.34"	669 mm
Width:	21.25”	540 mm
Depth:	4.44”	113 mm

RATINGS

- UL Listed and CSA Approved
- Meets NFPA requirements
- Meets OSHA requirements
- NEMA Type 1
- Constructed to IP40

REPLACEMENT PARTS

Description	***Part Number***
PC Board Assembly, Main	K200E904B
PC Board Assembly, Terminal	K200D903C
Transformer, Audio	K200A803B
Transformer, Power	K200A804B
Resistor, EOLR 2.7K	K200A770A
Resistor, EOLR 3.9K	K200A771A
Indicator Lamp	K149A112A
Remote Reset	K8551030B

HOW TO ORDER

- Specify model number
- Tone Module purchased separately (UTM)
- Connector Kit for speaker/amplifiers (300CKS)
- Speaker/amplifiers purchased separately (300GC, 50GC, etc.)
- Optional remote reset (part #K8551030B

REDACTED

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REDACTED

Appendix B: Sprinkler / Detector Information

Bulletin 013 Rev. M

Models F1 Series Standard Response Sprinklers

Model F156 Sprinkler Types
Standard Upright
Standard Pendent
Conventional
Vertical Sidewall
Horizontal Sidewall

Model F156 Recessed Sprinkler Types
Pendent/F1/F2/FP
Horizontal Sidewall

Model F142, F1XLH & F128 Sprinkler Types
Standard Upright
Standard Pendent

Model F142, F1XLH & F128 Recessed Sprinkler Types
Pendent/F1/F2/FP

Approval Organizations
1. Underwriters Laboratories Inc. and certified for Canada (cULus)
2. Factory Mutual Approvals (FM)
3. Loss Prevention Council (LPCB, UK)
4. VdS Schadenverhütung GmbH
5. EC Certificate: 0786-CPD-40237 (RA1314)
   0786-CPD-40253 (RA1325)
   0786-CPD-40254 (RA1375)

UL Listing Category
Sprinklers, Automatic & Open (VNIV)

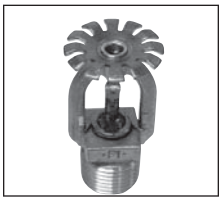
Product Description
The F156, F142, F1XLH & F128 Series Glass Bulb Sprinkler combines the durability of a standard sprinkler with the attractive low profile of a decorative sprinkler. Whether installed on exposed piping or in an office ceiling, it is functional and attractive.

Beautifully versatile is the description for the Reliable Models F156, F142, F1XLH & F128 Series Recessed glass bulb sprinkler. Recessing the F156, F142, F1XLH & F128 Series enhances its already low profile decorative appearance, and facilitates a rapid and perfect installation.

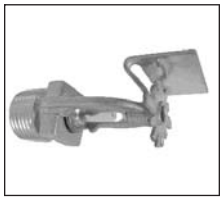
The recessed escutcheon of the Models F156, F142, F1XLH & F128 are highly adjustable. The two piece construction makes field installation a very easy and rapid task. This also allows ceiling panels to later be removed without shutting down the fire protection system, thus facilitating maintenance of above ceiling services.


Upright

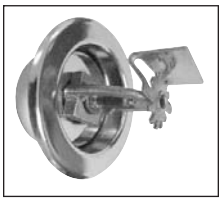

Pendent


Conventional


Vertical Sidewall


Horizontal Sidewall


Recessed Pendent/F1/F2

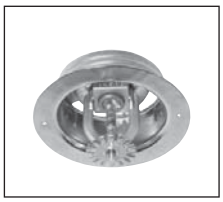

Recessed Horizontal Sidewall


Recessed Pendent/FP


XLH Upright


XLH Pendent

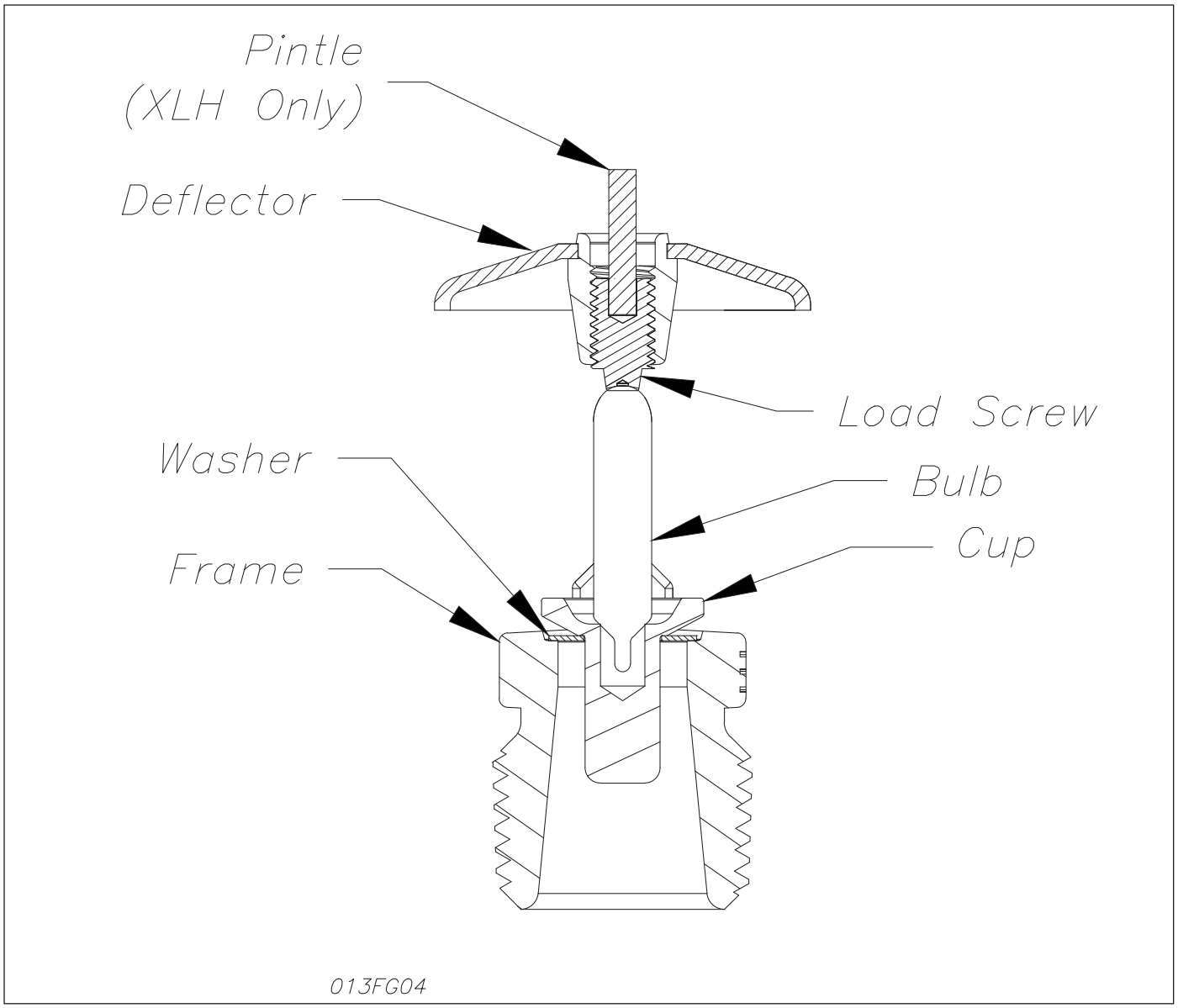

XLH Recessed Pendent F1/F2


XLH Recessed Pendent FP

The F156, F142, F1XLH & F128 Series Automatic Sprinkler utilizes a 5.0 mm frangible glass bulb. The glass bulb consists of an accurately controlled amount of special fluid hermetically sealed inside a precisely manufactured glass capsule. This glass bulb is specially constructed to provide fast thermal response.

At normal temperatures, the glass bulb contains the fluid in both the liquid phase and in the vapor phase. The vapor phase can be seen as a small bubble. As heat is applied, the liquid expands forcing the bubble smaller and smaller as the liquid pressure increases. Continued heating forces the liquid to push out against the bulb, causing the glass to shatter, opening the waterway and allowing the deflector to distribute the discharging water.

The F156, F142, F1XLH & F128 Series Sprinkler temperature rating is identified by the color of the glass bulb capsule as well as frame color where applicable.



Model F142, F1XLH Upright

Technical data:

Models	Nominal K-Factor	Response	Thread Size	Max. Working Pressure	Min. Working Pressure	Temperature Rating	Finish
F156	5.6 (80 Metric)	Standard	½" NPT (R½)	175 PSI[1]	7 PSI	See "Temperature Ratings" Table	See "Finish Table"
F142 F1XLH	4.2 (60 Metric)						
F128	2.8 (40 Metric)						

Material Data:

Frame	Deflector	Load Screw	Pintle	Cup	Washer	Bulb
DZR Brass QM Brass	CDA Alloy 260, CDA Alloy 220 or CDA Alloy 510	CDA Alloy 360 or CDA Alloy 544	CDA Alloy 360 or CDA Alloy 544	CDA Alloy 651 or CDA Alloy 693	Nickel Alloy 440 or Alloy 360 coated with PTFE Adhesive Tape	Glass

[1] Model F156 upright, pendent, and recessed pendent sprinklers (SIN RA1325 and RA1314) are cULus Listed for 250 psi (17 bar).

Model F156, Upright, Pendent & Conventional Sprinklers
Model F142, F1XLH & F128 Upright & Pendent Sprinklers

Installation Wrench: Model D Sprinkler Wrench

Installation Data:

Nominal Orifice	Thread Size	Nominal K-Factor		Sprinkler Height	Approval Organization	Sprinkler Identification Number (SIN)	
		US	Metric			Upright	Pendent
Standard-Upright (SSU) and pendent Deflectors Marked to Indicate Position							
½" (15mm) [1]	½" NPT (R½)	5.6	80	2.25" (57mm)	1, 2, 3, 4, 5	RA1325[2][3][5][6]	RA1314[2][3][5][6]
7/16" (10mm)	½" NPT (R½)	4.2	60	2.25" (57mm)	1	RA1323[2][6]	RA1313[6]
3/8" (10mm)	½" NPT (R½)	2.8	40	2.25" (57mm)	1	RA1321[2][6]	RA1311[6]
Conventional-Install in Upright or Pendent Position							
15mm [1]	½" NPT (R½)	5.6	80	57mm	3, 4, 5	RA1375[5]	

[1] Refer to Bulletin 024 for Special Response Sprinklers (F1S5-56)
[2] cULus Listed corrosion resistant (Polyester coated) sprinkler.
[3] Polyester coated FM Approved sprinkler.
[4] _____
[5] Polyester coated LPCB & VdS approved sprinkler RA1325, RA1314 & RA1375.
[6] Electroless Nickel PTFE Plated - UL listed Corrosion Resistant

Upright

Pendent

Conventional

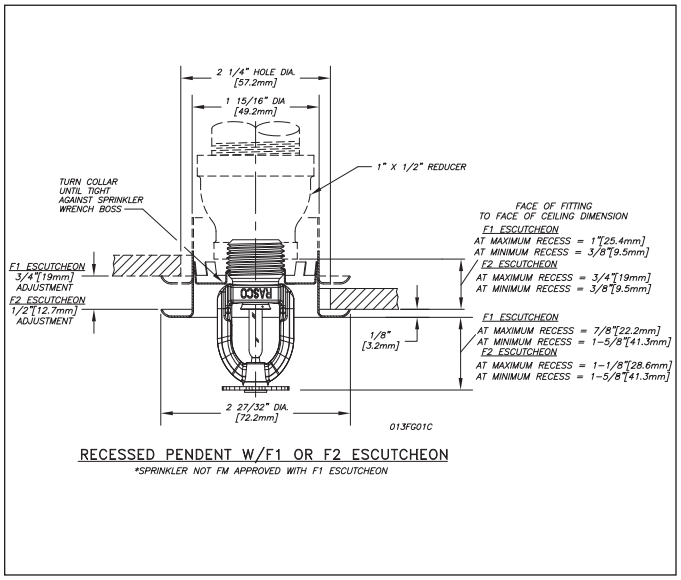
Model F156, F142, F1XLH & F128 Recessed Pendent Sprinklers[1]

Installation Wrench: Model GFR2 Sprinkler Wrench

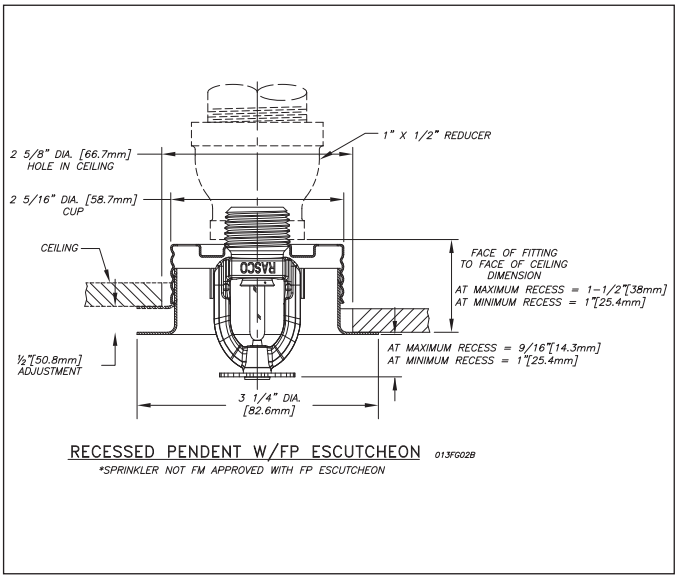
Installation Data:

Nominal Orifice	Thread Size	Nominal K-Factor		Sprinkler Height	Sprinkler Identification Number (SIN)
		US	Metric		
½" (15mm)	½" NPT (R½)	5.6	80	2.25" (57mm)	RA1314[2]
7/16" (10mm)	½" NPT (R½)	4.2	60	2.25" (57mm)	RA1313[2]
3/8" (10mm)	½" NPT (R½)	2.8	40	2.25" (57mm)	RA1311[2]

[1] Refer to escutcheon data table for approvals & dimensions
[2] Electroless Nickel PTFE Plated - cULus listed Corrosion Resistant



Model F156, F142, F1XLH & F128 F1 or F2



Model F156, F142, F1XLH & F128 FP

Model F156 Vertical Sidewall Sprinkler

Installation Wrench: Model D Sprinkler Wrench
Installation Position: Upright or Pendent
Approval Type: Light Hazard Occupancy

U.S. Patent No. 6,374,920

Sprinkler Type	Deflector to Ceiling Distance (Min. - Max.)
Upright	4" (102mm) - 12" (305mm)
Pendent	4" (102mm) - 12" (305mm)

Vertical Sidewall

Installation Data:

Nominal Orifice	Thread Size	Nominal K Factor		Sprinkler Height	Approval [1] Organizations	Sprinkler Identification Numbers (SIN)
		US	Metric			
½" (15mm)	½" NPT (R½)	5.6	80	2.25" (57mm)	1, 2, 3	RA1385[1][2][3][4]

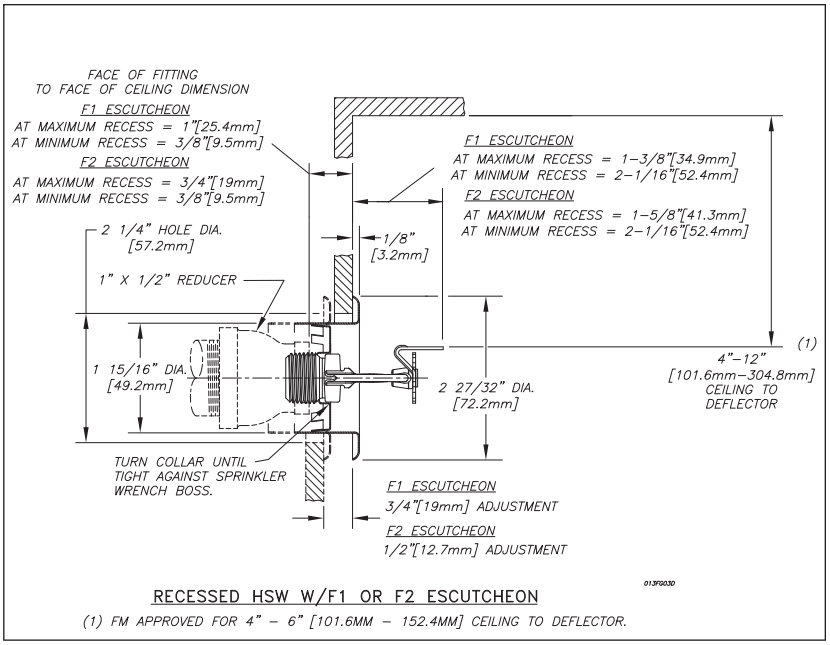
[1] LPC Approval is pendent only, 57°C through 141°C ratings.
[2] cULus Listed corrosion resistant (Polyester coated) sprinkler.
[3] cULus Listed & FM Approved corrosion resistant for lead, wax and wax over lead.
[4] Electroless Nickel PTFE Plated - cULus listed Corrosion Resistant

Model F156 Horizontal Sidewall Sprinkler

Deflector: HSW

Installation Wrench: Model D Sprinkler Wrench

Horizontal Sidewall



Note: For Recessed HSW Sprinklers use installation wrench GFR2. FM and cULus permits use with F1 or F2 escutcheons for "Light Hazard" only.

Installation Data: Horizontal Sidewall

Nominal Orifice	Thread Size	Nominal K Factor		Sprinkler Height	Approval Organizations		Sprinkler Identification Numbers (SIN)
		US	Metric		Light Hazard	Ordinary Hazard	
½" (15mm)	½" NPT (R1/2)	5.6	80	2.63" (67mm)	1, 2	1	RA1335[1][2][3][4]

[1] cULus Listed corrosion resistant (Polyester coated) sprinkler.
[2] cULus Listed & FM Approved corrosion resistant for lead, wax and wax over lead.
[3] Polyester coated FM approved sprinkler.
[4] Electroless Nickel PTFE Plated - cULus listed Corrosion Resistant

Application

Model F156, F142, F1XLH, F128 & Model F156, F142, F1XLH & F128 Recessed sprinklers are used in fixed fire protection systems: Wet, Dry, Deluge or Preaction. Care must exercised that the orifice size, temperature rating, deflector style and sprinkler type are in accordance with the latest published standards of the National Fire Protection Association or the approving Authority Having Jurisdiction Installation.

Installation

Model F156, F142, F1XLH & F128 Series sprinklers are standard response sprinklers intended for installation as specified in NFPA 13. They must also be installed with the Model D Sprinkler Wrench specifically designed by Reliable for use with these sprinklers.

The Model F156, F142, F1XLH & F128 Recessed Sprinklers are to be installed with a maximum recess of ¾ inch (19mm). The Model F1, F2, and FP Escutcheon illustrated are the only recessed escutcheon to be used with the Model F156, F142, F1XLH & F128 Recessed Sprinklers. The use of any other recessed escutcheon will void all approvals and negate all warranties. When installing Model F156, F142, F1XLH & F128 Recessed Sprinklers use the Model GFR2 Sprinkler Wrench. Any other type of wrench may damage these sprinklers.

Note: A leak tight ½" NPT (R½) sprinkler joint can be obtained with a torque of 8 - 18 ft-lbs (11 - 24 N-m). Do not tighten sprinklers over maximum recommended torque. It may cause leakage or impairment of the sprinklers.

Glass bulb sprinklers have orange covers to protect the bulb during the installation process. REMOVE THIS PROTECTION ONLY AFTER THE SYSTEM HAS BEEN HYDROSTATICALLY TESTED AND, WHEN APPLICABLE, THE ESCUTCHEONS HAVE BEEN INSTALLED. RASCO wrenches are designed to install sprinklers when covers are in place.

Ordering Information

Specify:

1. Sprinkler Model
2. Sprinkler Type
3. Nominal K-Factor
4. Temperature Rating
5. Sprinkler Finish
6. Thread Type: [½" NPT] [ISO 7-1R½]
7. Escutcheon Finish (where applicable)

Note: When Models F156, F142, F1XLH & F128 Recessed Sprinklers are ordered, the sprinklers and escutcheons are packaged separately.

Escutcheon Data [1]

[1] SIN: RA1335 - cULus and FM permits use with F1 or F2 escutcheons for light hazard only.

Maintenance

The Model F156, F142, F1XLH & Model F156, F142, F1X-LH & F128 Recessed Sprinklers should be inspected and the sprinkler system maintained in accordance with NFPA 25. Do not clean sprinklers with soap and water, ammonia or any other cleaning fluid. Replace any sprinkler which has been painted (other than factory applied) or damaged in any way. A stock of spare sprinklers should be maintained to allow quick replacement of damaged or operated sprinklers. Prior to installation, sprinklers should be maintained in the original cartons and packaging until used to minimize the potential for damage to sprinklers that would cause improper operation or non-operation.

Temperature Ratings

Classification	Sprinkler Temperature		Max. Ambient Temp.	Bulb Color
	°C	°F		
Ordinary	57	135	100°F (38°C)	Orange
Ordinary	68	155	100°F (38°C)	Red
Intermediate	79	175	150°F (66°C)	Yellow
Intermediate	93	200	150°F (66°C)	Green
High[1]	141	286	225°F (107°C)	Blue
Extra High[1]	182	360	300°F (149°C)	Mauve
Ultra High [1] [2]	260	500	475°F (246°C)	Black

[1] Not available for recessed Sprinklers.
[2] cULus listed for SIN RA1325 and RA1314 only.

Maximum Working Pressure

175 psi (12 bar)
SIN RA1325 & RA1314 cULus listed for 250 psi (17 bar)
100% Factory tested hydrostatically to 500 psi (34.5 bar)

Finish[1]

Standard Finishes	
Sprinkler	**Escutcheon**
Bronze	Brass
Chrome	Chrome
Polyester Coated [6][7][9]	White Painted
Special Application Finishes	
Sprinkler	**Escutcheon**
Electroless Nickel PTFE[3][10]	Electroless Nickel PTFE
Bright Brass[2]	Bright Brass
Black Plated	Black Plated
Black Paint[3][9]	Black Paint
Off White[3][9]	Off White
Chrome Dull	Chrome Dull
Lead Plated[3][4][8]	
Wax Coated[3][4][5][8]	
Wax Over Lead[3][4][5][8]	

[1] Other colors and finishes are available on special order. Consult factory for details. Custom color painted sprinklers may not retain their UL Corrosion resistance listing.
[2] 200°F (93°C) maximum.
[3] UL and ULC listed only.
[4] 155°F to 200°F (68°C to 93°C) ratings only.
[5] 286°F (141°C) sprinklers may be coated for ambient conditions not exceeding 150°F (66°C).
[6] cULus listed "corrosion resistant" applies to SIN Number RA1325 (Upright) RA1323 (upright), RA1321(Upright), RA1335 (HSW), RA1385(VSW) and RA1314 (Pendent) in standard black or white. Corrosion resistance in other polyester colors is available upon request.
[7] FM Approved finish as "Polyester Coated" applies to SIN number RA1314, RA1335 & RA1325 in standard black or white.
[8] FM Approved finish applies only to SIN number RA1335 & RA1385.
[9] LPCB and VdS Approved finish applies only to RA1325, RA1314 and RA1375.
[10] cULus listed Corrosion Resistant applies to SIN RA1325 ,RA1314 ,RA1323, RA1313 ,RA1321, RA1311, RA1385 and RA1335

Reliable...For Complete Protection

Reliable offers a wide selection of sprinkler components. Following are some of the many precision-made Reliable products that guard life and property from fire around the clock.

- Automatic sprinklers
- Flush automatic sprinklers
- Recessed automatic sprinklers
- Concealed automatic sprinklers
- Adjustable automatic sprinklers
- Dry automatic sprinklers
- Intermediate level sprinklers
- Open sprinklers
- Spray nozzles
- Alarm valves
- Retarding chambers
- Dry pipe valves
- Accelerators for dry pipe valves
- Mechanical sprinkler alarms
- Electrical sprinkler alarm switches
- Water flow detectors
- Deluge valves
- Detector check valves
- Check valves
- Electrical system
- Sprinkler emergency cabinets
- Sprinkler wrenches
- Sprinkler escutcheons and guards
- Inspectors test connections
- Sight drains
- Ball drips and drum drips
- Control valve seals
- Air maintenance devices
- Air compressors
- Pressure gauges
- Identification signs
- Fire department connection

The equipment presented in this bulletin is to be installed in accordance with the latest published Standards of the National Fire Protection Association, Factory Mutual Research Corporation, or other similar organizations and also with the provisions of governmental codes or ordinances whenever applicable. Products manufactured and distributed by Reliable have been protecting life and property for over 90 years, and are installed and serviced by the most highly qualified and reputable sprinkler contractors located throughout the United States, Canada and foreign countries.

Manufactured by

Reliable®

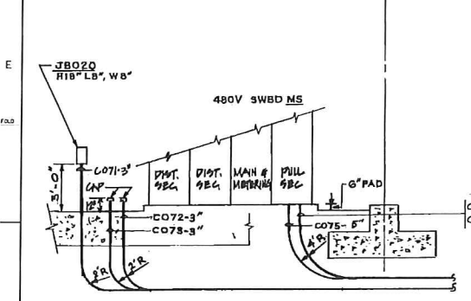
Reliable Automatic Sprinkler Co., Inc.
(800) 431-1588 Sales Offices
(800) 848-6051 Sales Fax
(914) 829-2042 Corporate Offices
www.reliablesprinkler.com Internet Address

Recycled Paper

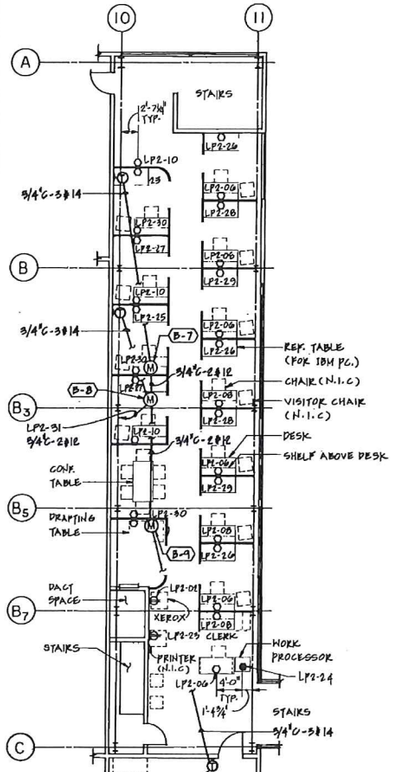
Revision lines indicate updated or new data.

EG. Printed in U.S.A. 12/15 P/N 9999970299

Appendix C: Alarm Locations

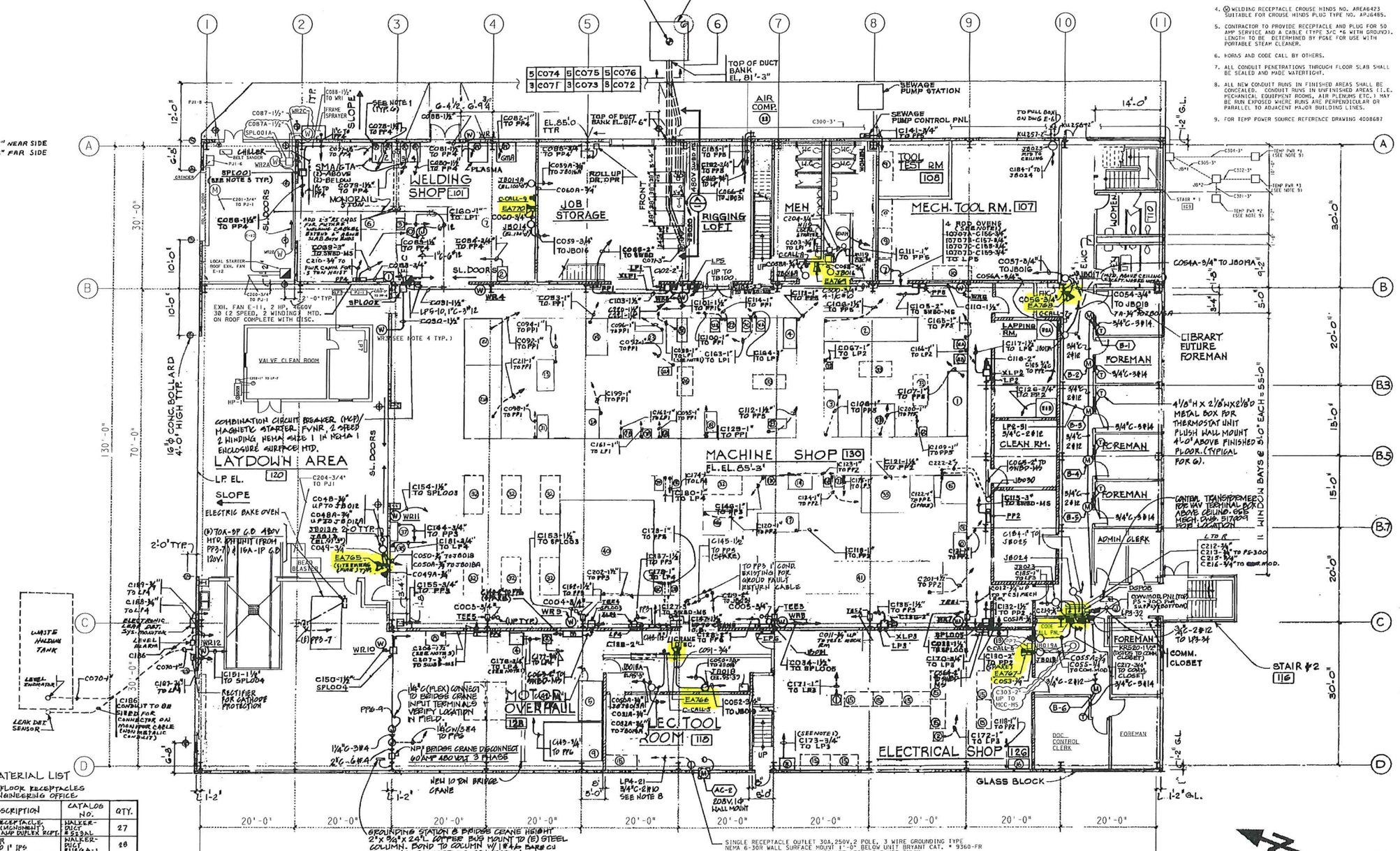


SECTION (A) — SCALE : NONE



4"Ø"H X 2"Ø"W X 2"Ø"D
METAL BOX FOR THERMOSTAT UNIT FLUSH WALL MOUNT 4'-0" ABOVE FINISHED FLOOR. (TYPICAL FOR 8)

ENGINEERING OFFICE
RECEPTACLE AND FLOOR PLAN
EL. 97'-3"



4. ⊗ WELDING RECEPTACLE CROUSE HINDS NO. AREA6423 SUITABLE FOR CROUSE HINDS PLUG TYPE NO. APJG6485.
5. CONTRACTOR TO PROVIDE RECEPTACLE AND PLUG FOR 50 AMP SERVICE AND A CABLE (TYPE 3/C #6 WITH GROUND). LENGTH TO BE DETERMINED BY PG&E FOR USE WITH PORTABLE STEAM CLEANER.
6. HORNS AND CODE CALL BY OTHERS.
7. ALL CONDUIT PENETRATIONS THROUGH FLOOR SLAB SHALL BE SEALED AND MADE WATERTIGHT.
8. ALL NEW CONDUIT RUNS IN FINISHED AREAS SHALL BE CONCEALED. CONDUIT RUNS IN UNFINISHED AREAS (I.E. MECHANICAL EQUIPMENT ROOMS, AIR PLENUMS ETC.) MAY BE RUN EXPOSED WHERE RUNS ARE PERPENDICULAR OR PARALLEL TO ADJACENT MAJOR BUILDING LINES.
9. FOR TEMP POWER SOURCE REFERENCE DRAWING 4008687

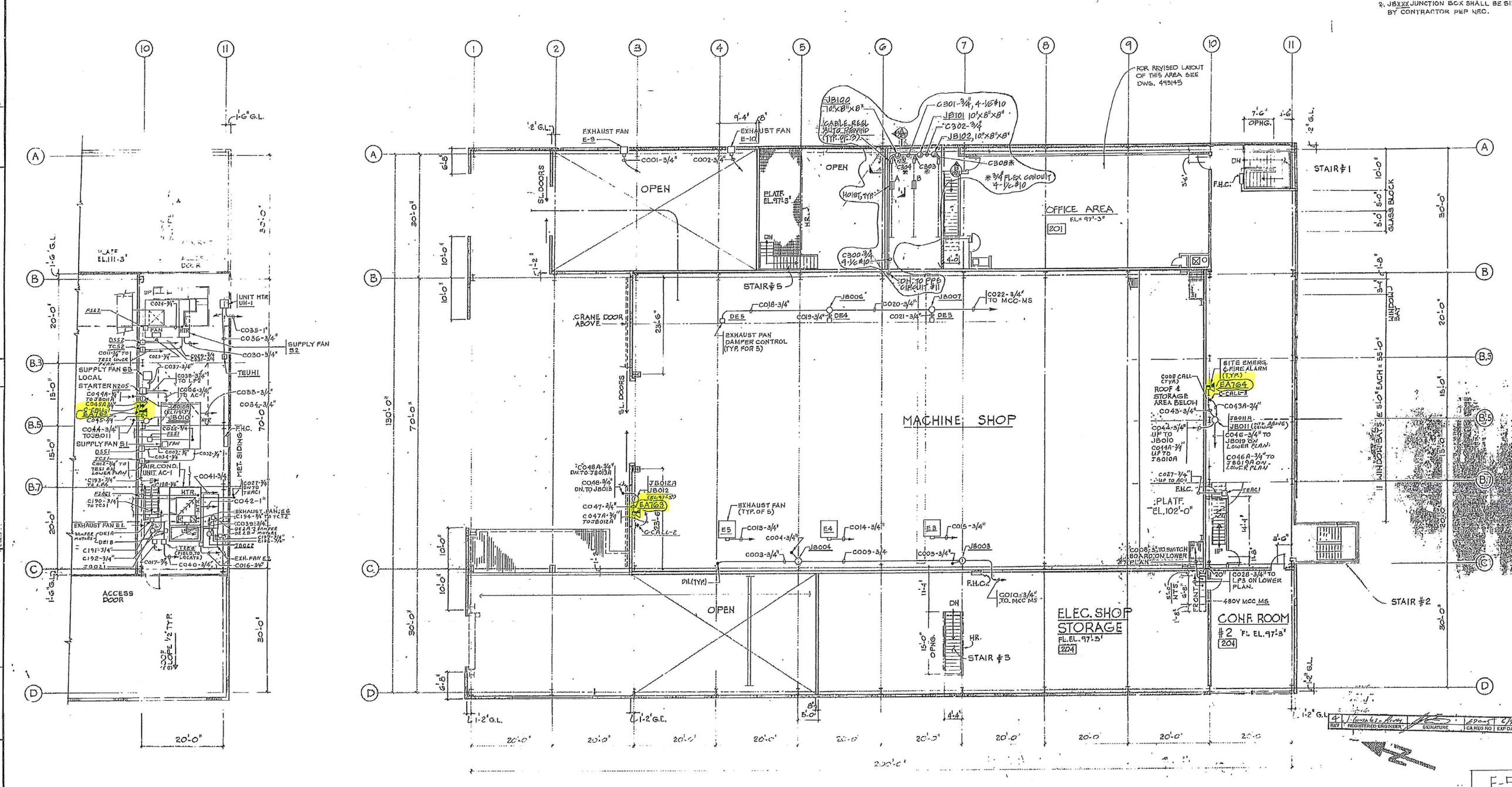
MATERIAL LIST
FOR FLOOR RECEPTACLES IN ENGINEERING OFFICE

SYMBOL	DESCRIPTION	CATALOG NO.	QTY.
○	FLOOR RECEPTACLE, OUTLET (MONUMENT) WITH 20 AMP DUPLEX RCPT.	WALKER-DUCT # 2132AL	27
	ADAPTER 2" I.P.S. TO 1" I.P.S.	WALKER-DUCT #1162A-1	28
	NO SPIN LOCKING NIPPLE 1" I.P.S. - 1" LONG	WALKER-DUCT #1164-1	28
	AFTER SET INSERT	WALKER-DUCT # 2132-2-3/8	28

ADDITIONAL SYMBOL

E-4

2. JBXXX JUNCTION BOX SHALL BE BY CONTRACTOR PER NEC.



REDACTED

Appendix D: Alarm Information

FEDERAL SIGNAL CORPORATION

SelecTone® Audible Signaling Device

Model 50GC

DESIGNED FOR INDOOR AND OUTDOOR USE

- Available in 24VAC/24VDC, and 120VAC
- Solid-state circuitry
- Built-in gain control, adjustable between 64dBA to 88dBA @ 10' (74dBA to 98dBA @ 1m)
- Flush or surface mount
- Type 3R enclosure
- UL and cUL Listed, and CSFM Approved

Federal Signal's Model 50GC SelecTone® Speaker Amplifier is designed to produce crisp, clear tones, digital voice messages and live public address.

In the Model 50GC a short, folded re-entrant horn is interposed between the diaphragm and surrounding air space. This design provides optimal dBA output and very good frequency response.

The 50GC is UL Listed. It has been designed, tested and approved for use in Type 3R applications. When installed with the Model WB Weatherproof Backbox, the 50GC is suitable for use outdoors.

Internal gain control allows output adjustment from 64dBA to a maximum of 88dBA at 10 feet.

SelecTone Speaker Amplifiers are used individually or as part of a plant-wide emergency notification system. The Model UTM Universal Tone Module, with 32 tones, or the TM33 Custom Tone Module is plugged into a single SelecTone Speaker Amplifier for stand-alone use or into a SelecTone Command Unit for plant-wide signaling.

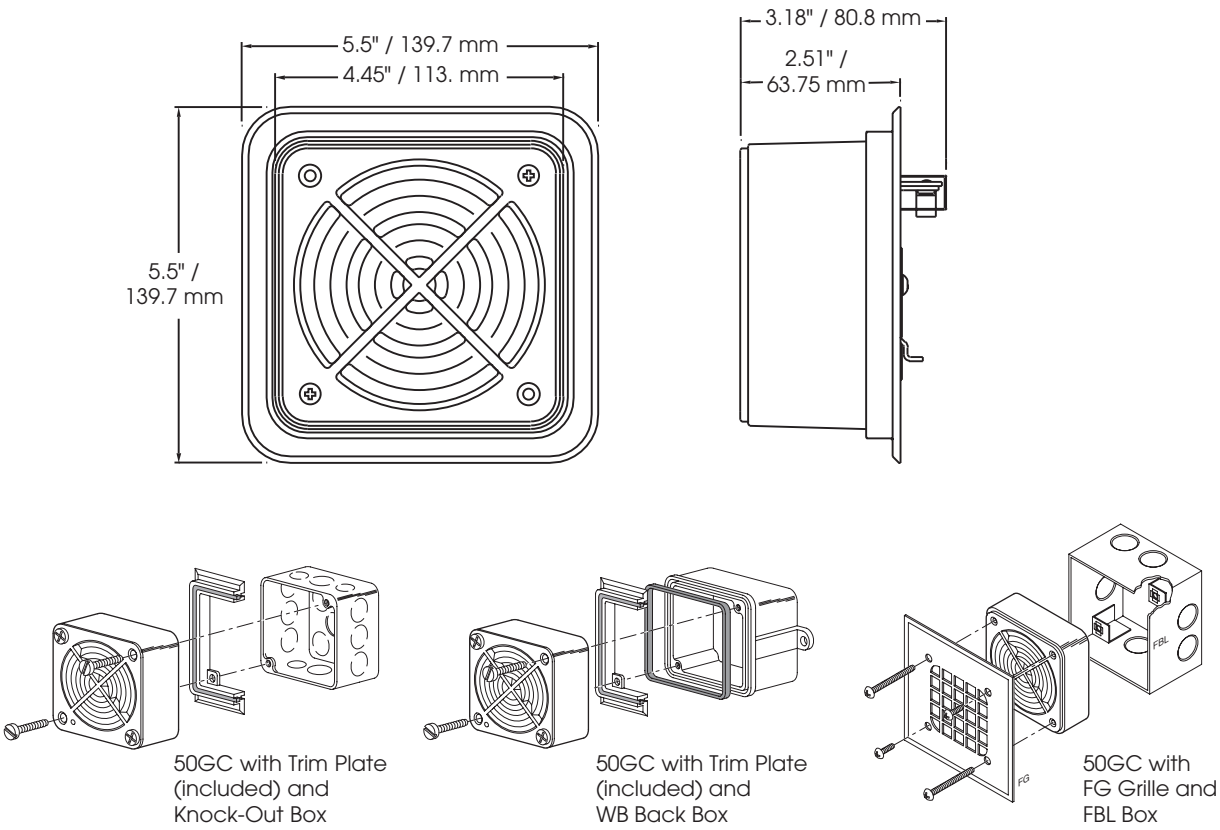
For plant-wide signaling, a Connector Kit is installed into each SelecTone Speaker Amplifier and wired to a central controller. SelecTone Command Units and CommCenter® Digital Message Centers broadcast tones, voice messages, melodies and live public address to an unlimited number of SelecTone Speaker Amplifiers.

The compact size and attractive appearance of the Model 50GC make it ideal for use in offices, hallways, reception, and plant areas where ambient noise levels are not exceedingly high, and even sound dispersal is desired. Emergency signaling and paging are common applications.

Model	Voltage	Operating Current	Standby Current	Decibels @ 10'	Decibels @ 1m
50GC-024BG	24VDC	0.09 amps	0.025 amps	88	98
50GC-024BG	24VAC 50/60Hz	0.29 amps	0.095 amps	88	98
50GC-120BG	120VAC 50/60Hz	0.04 amps	0.027 amps	88	98

5 yr FEDERAL SIGNAL WARRANTY

SELECTONE® AUDIBLE SIGNALING DEVICE (50GC)



SPECIFICATIONS

Operating Temperature:	-31°F to 161°F	-35°C to 72°C
Net Weight:	1.7 lbs.	0.8 kg
Shipping Weight:	2.2 lbs.	1.0 kg
Height:	5.5"	139.7 mm
Width:	5.5"	139.7 mm
Depth:	3.18"	80.8 mm

REPLACEMENT PARTS

Description	***Part Number***
Kit, Trim Ring and Gasket	K8476123A

HOW TO ORDER

- Specify model and voltage
- Specify Tone Module for stand alone operation (sold separately)
  - Universal Tone Module (UTM)
  - Custom Tone Module (TM33)
- Specify Connector Kit (sold separately) for use in systems (Call factory for system design assistance)
  - 25 Vrms Connector Kit (AM25CK)
  - 70 Vrms Connector Kit (AM70CK)
- Specify Accessories:
  - Weatherproof Back Box (WB)
  - Grille (FG)
  - Flush Mount Back Box (FBL)

FEDERAL SIGNAL CORPORATION

Vibratone® Bells

Models A4, A6 and A10
Models 500 and 600

DESIGNED FOR GENERAL ALARM OR PAGING

- Vibrating mechanism
- Three gong sizes – four, six, or ten-inch
- A range of output available – 98-102dBA @ 10' (108-112dBA @ 1m)
- Optional weatherproof backbox provides Type 3R enclosure
- UL and cUL Listed, CSA Certified and FM Approved

Federal Signal's Vibratone® heavy duty bell product line utilizes a modular approach to combine gongs and mechanisms allowing for greater flexibility and selection. Three gong sizes are available: the Model A4 is four inches in diameter, the Model A6 is six inches in diameter, and the Model A10 is ten inches in diameter. Each larger gong produces a different tone and a higher dBA output.

Vibrating bells produce a continuous ringing sound when voltage is applied. The Models 500 and 600 vibrating mechanisms are designed for AC and DC operation, respectively.

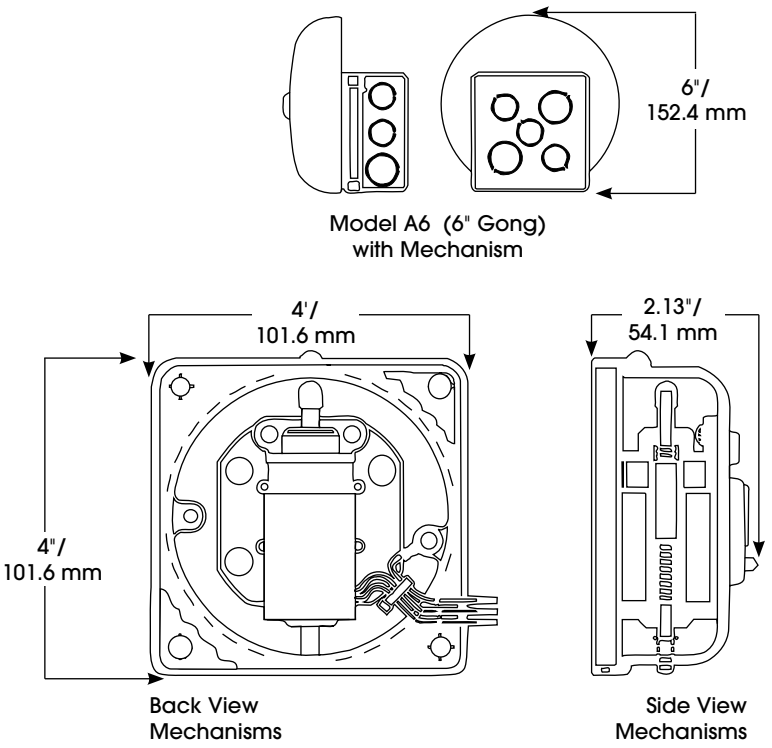
The Models 500 and 600 are UL and cUL Listed, CSA Certified and FM Approved.

Federal Signal's Vibratone bells can be used in any industrial application, whether to signal danger or for start and dismissal. A variety of mounting accessories will accommodate almost any environment.

Model	Voltage	Operating Current	Decibels @ 10'	1m
BELLS				
A4	–	–	98	108
A6	–	–	100	110
A10	–	–	102	112
VIBRATING MECHANISMS				
500-024-1	24VAC	0.4 amps	–	–
500-120-1	120VAC	0.08 amps	–	–
500-240-1	240VAC	0.04 amps	–	–
600-012-1	12VDC	0.8 amps	–	–
600-024-1	24VDC	0.4 amps	–	–
600-125-1	125VDC	0.08 amps	–	–

5 yr FEDERAL SIGNAL WARRANTY

VIBRATONE® BELLS (A4/A6/A10/500/600)



SPECIFICATIONS

Model	*Net Weight*	*Shipping Weight*	*Height*	*Width*	*Depth*
500	1.0 lb. 0.45 kg	1.1 lb. 0.4 kg	4.0" 101.6 mm	4.0" 101.6 mm	2.125" 54.0 mm
600	1.0 lb. 0.45 kg	1.1 lb. 0.4 kg	4.0" 101.6 mm	4.0" 101.6 mm	2.125" 54.0 mm
A4	0.5 lb. 0.23 kg	0.7 lb. 0.32 kg	4.0" 101.6 mm	4.0" 101.6 mm	1.25" 31.8 mm
A6	1.0 lb. 0.45 kg	1.2 lb. 0.54 kg	6.0" 152.4 mm	6.0" 152.4 mm	1.75" 44.5 mm
A10	3.5 lbs. 1.59 kg	4.0 lbs. 1.8 kg	10.0" 254.0 mm	10.0" 254.0 mm	2.25" 57.2 mm

HOW TO ORDER

- Specify mechanism model and voltage, and gong model*
- Specify accessories from list

* Each gong sold separately

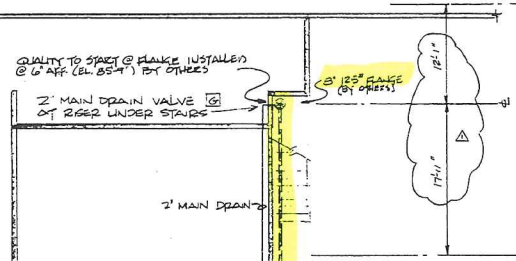
ACCESSORIES

FB	Deep back box for flush mounting A4 gong with any mechanism
FBL	Extra deep back box for flush mounting A4 gong with any mechanism
FG	Grille for flush mounting A4 gong and any mechanism in FB back box
SF	Surface mounting plate for plastered-in 4" boxes
WB	Weatherproof back box

Appendix E: Sprinkler Layouts

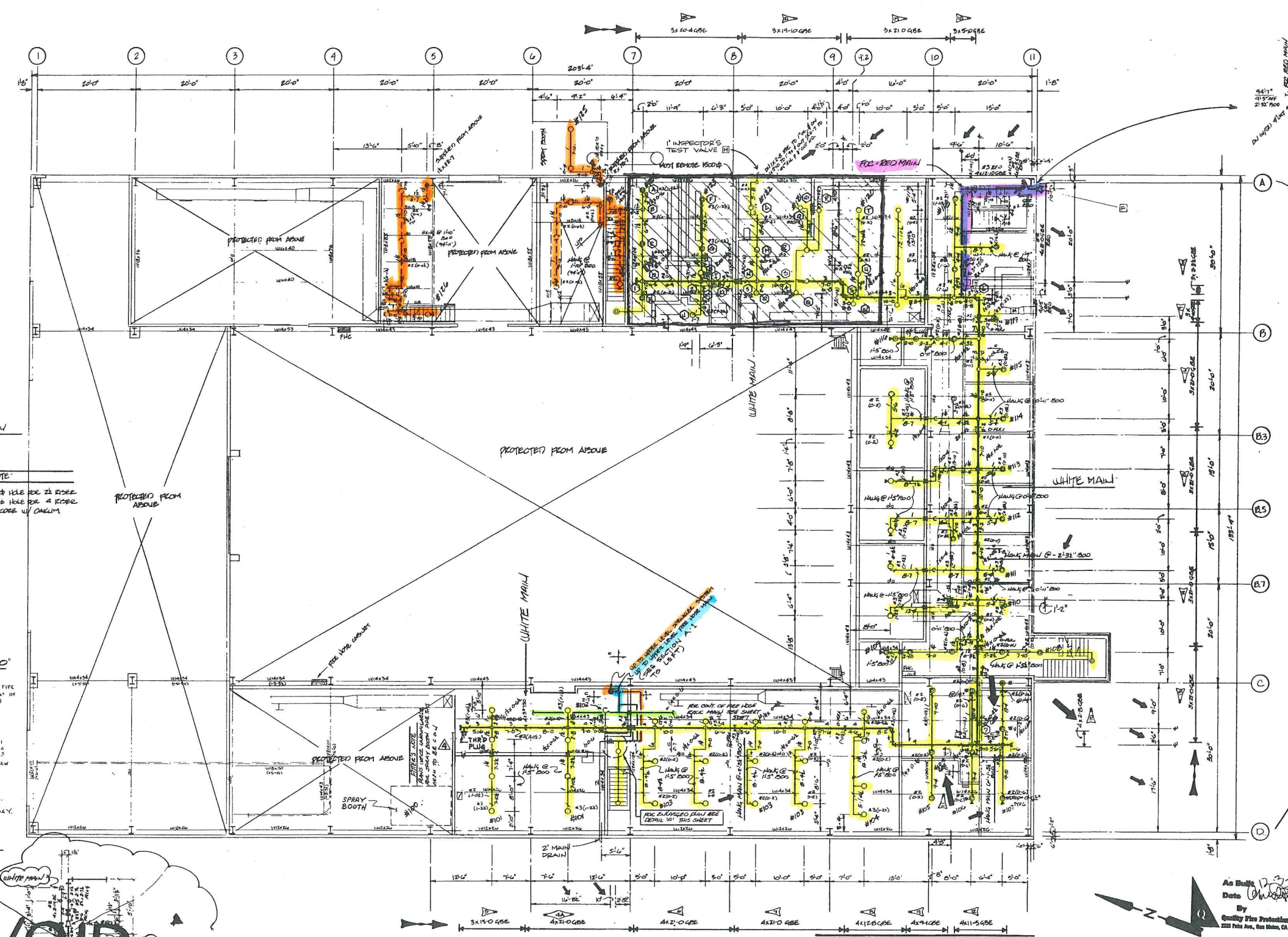
REDACTED

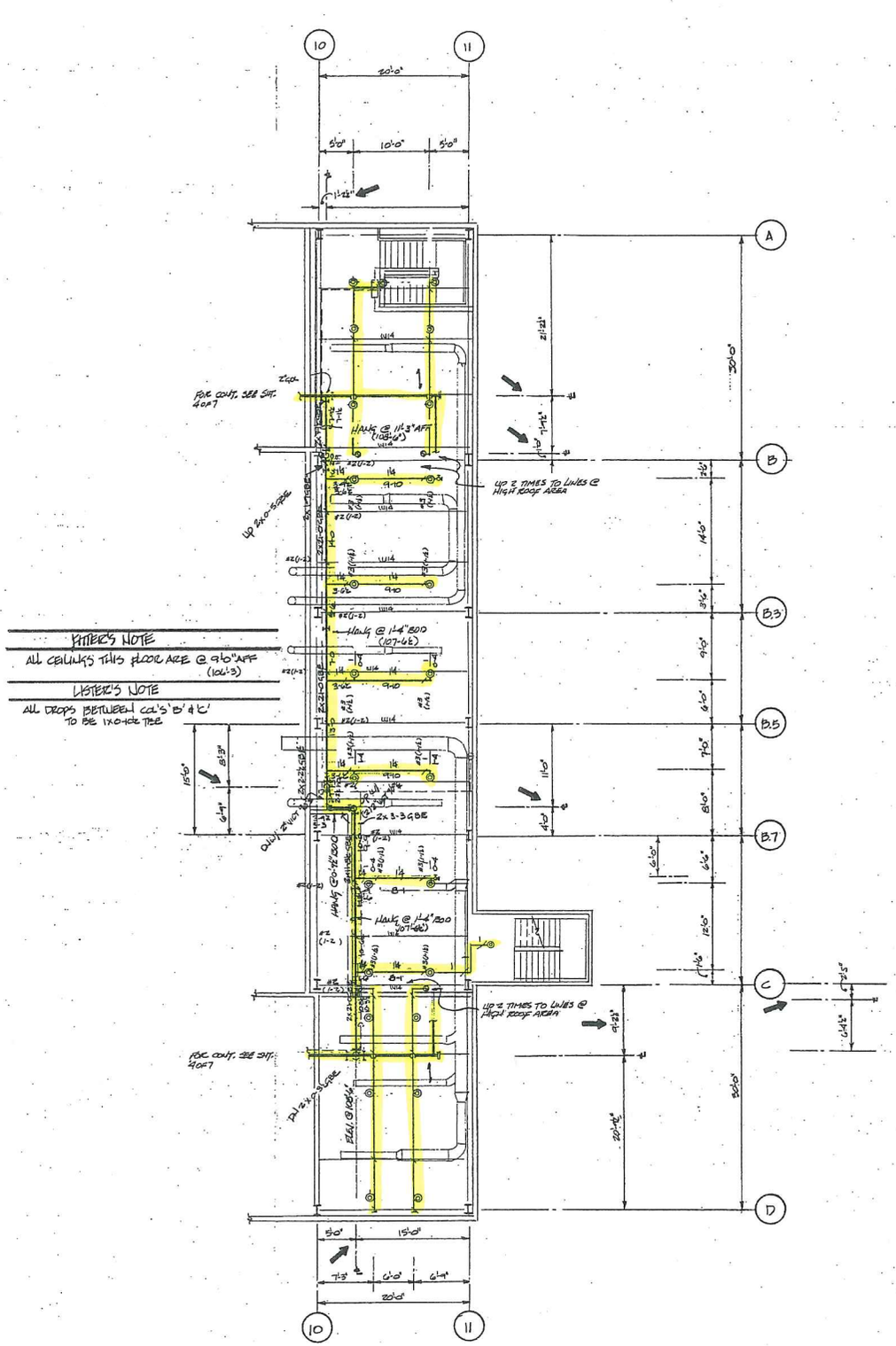
PACIFIC GAS & ELECTRIC COLD MACHINE SHOP



As Built
Date 12-3-85
By
Quality Fire Protection, Inc.
2233 Palm Ave., San Mateo, CA 94403

MEGS. REC.
APR 6 1987


PROTECTED FROM ABOVE
WHITE MAIN
FDC - RED MAIN
1" INSPECTOR'S TEST VALVE
SPRAY BOOTH
FIRE HOSE CABINET
2" MAIN DRAIN
SEE ENLARGED PLAN SEE DETAIL 1/A1 THIS SHEET
As Built
Date
By
Quality Fire Protection
2220 Palm Ave., San Mateo, CA



LEVEL TWO (ENG.'S AREA) SPRINKLER PIPING PLAN
SCALE: 1/8" = 1'-0"

LIFTER LEVEL FIRE HOSE CABINET PIPING PLAN
SCALE: 1/8" = 1'-0"

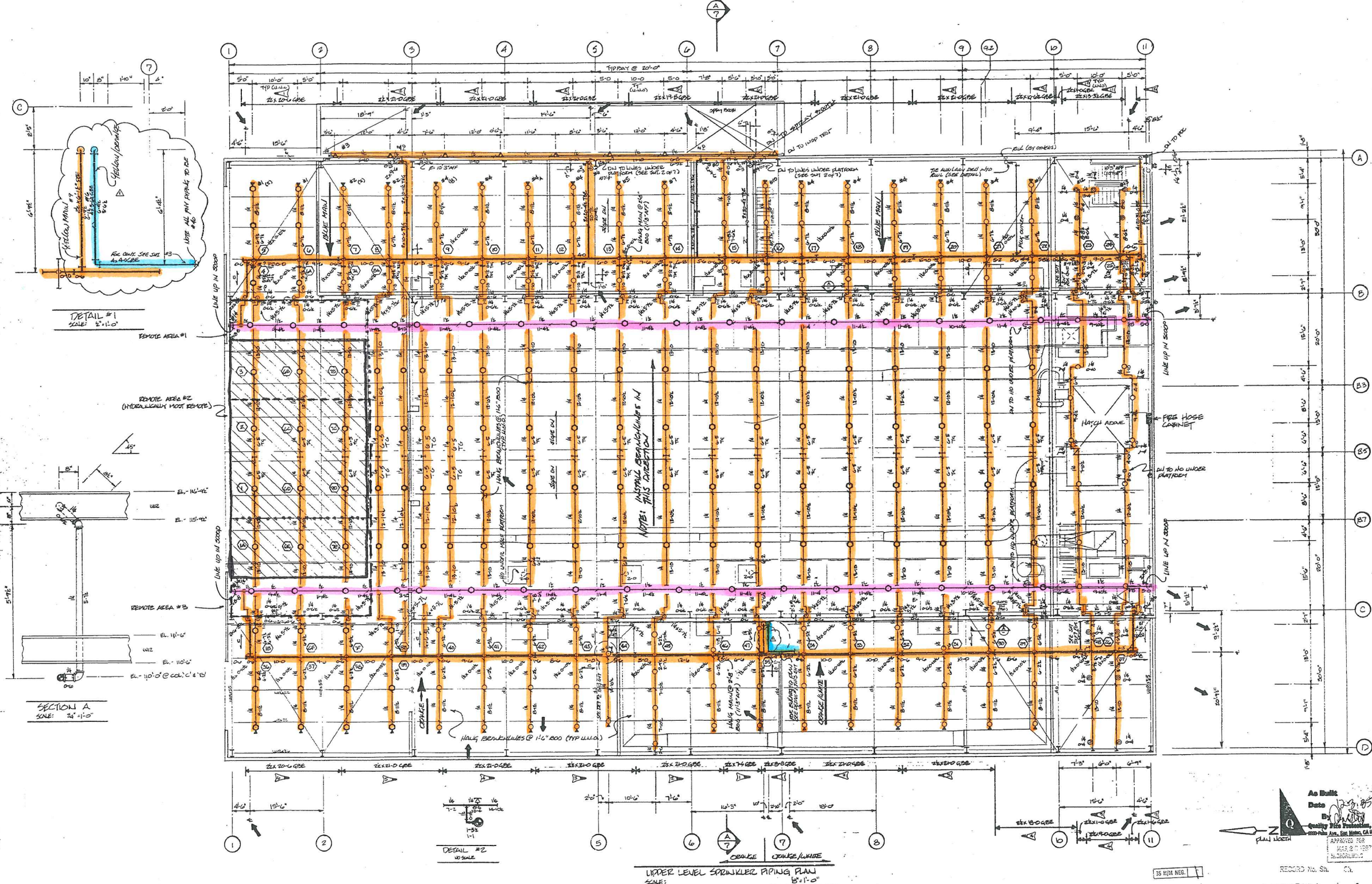
NOTE: FIRE HOSE CABINETS ARE E TYP.

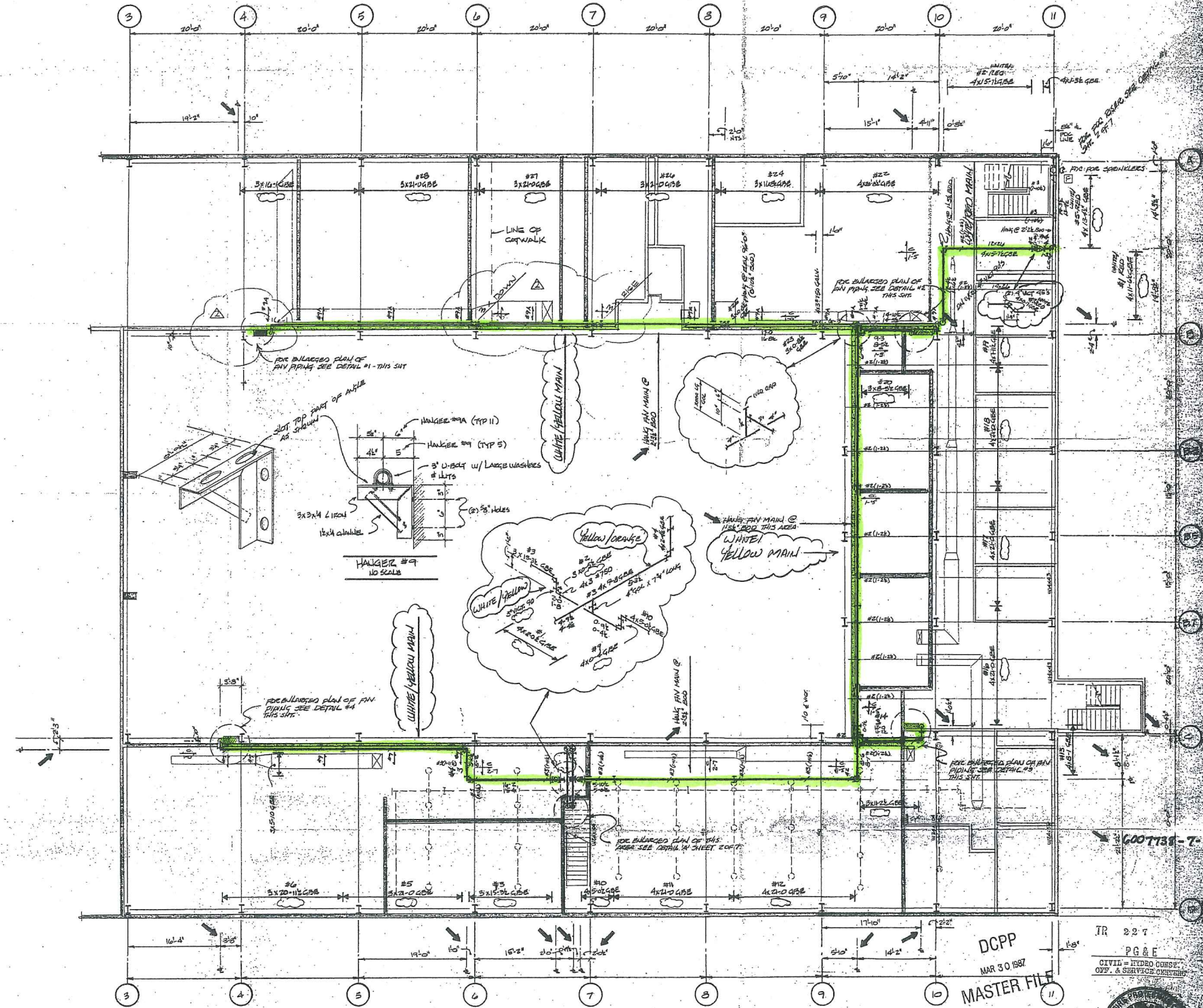
PLAN NORTH

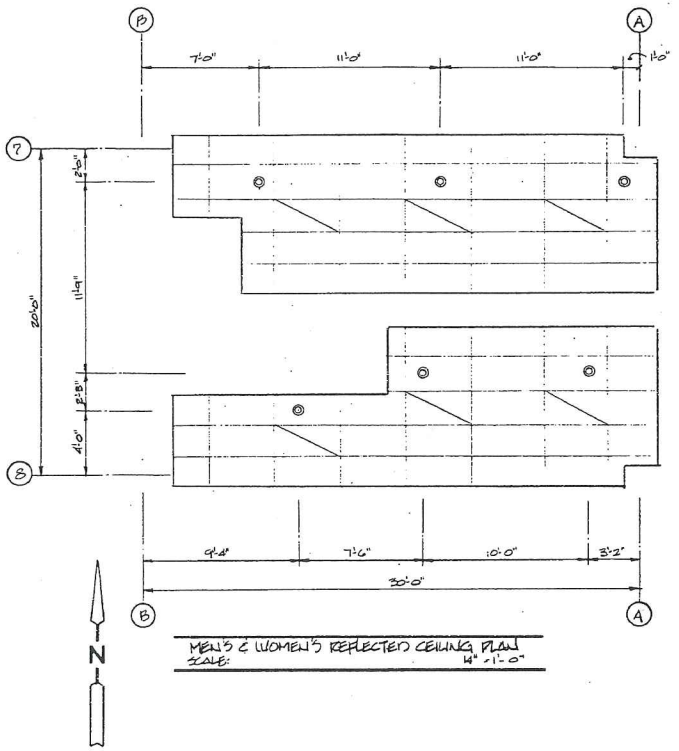
DCPP
MAR 30 1987
MASTER FILE

As Built
Date: 3-7-85
By
Quality Fire Protection, Inc.
2233 Palm Ave., San Mateo, CA 94403

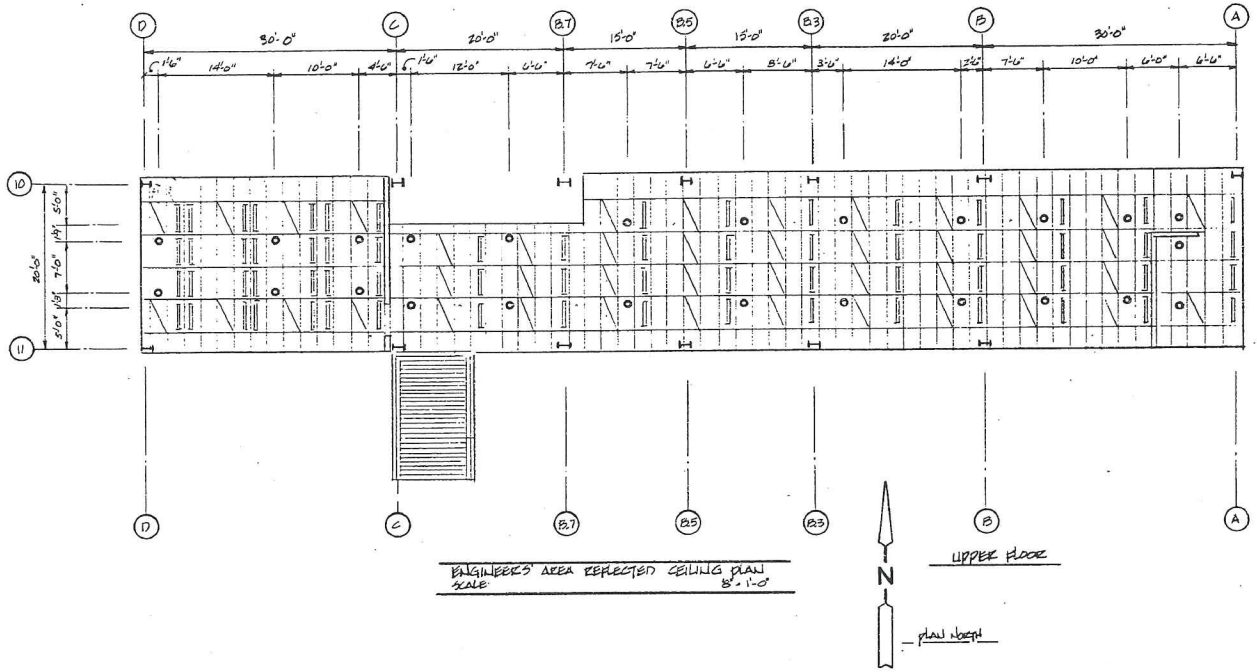
6007738-3


DETAIL #1
SCALE: 3/4"=1'-0"
REMOTE AREA #1
REMOTE AREA #2
(HYDRAULICALLY MOST REMOTE)
REMOTE AREA #3
SECTION A
SCALE: 3/4"=1'-0"
DETAIL #2
NO SCALE
UPPER LEVEL SPRINKLER PIPING PLAN
SCALE: 1/8"=1'-0"
FIRE HOSE CABINET
HATCH ABOVE
NOTE: INSTALL BRANCHLINES IN THIS DIRECTION
BLUE MAIN
GRADE/LUMBER
As Built
Date
By
Quality Fire Protection,
APPROVED FOR
MAR 2 7 1997
BUILDING
35 M/M NEG.
RECORD No. SH. CN.


LINE OF CATWALK
FOR BILLARDED PLAN OF FIRE PIPING SEE DETAIL #1 - THIS SHT
FOR BILLARDED PLAN OF FIRE PIPING SEE DETAIL #2 THIS SHT
FOR BILLARDED PLAN OF FIRE PIPING SEE DETAIL #4 THIS SHT
FOR BILLARDED PLAN OF FIRE PIPING SEE DETAIL #3 THIS SHT
FOR BILLARDED PLAN OF THIS AREA SEE DETAIL 'A' SHEET 20FT
HANGER #9 NO SCALE
HANGER #9A (TYP 11)
HANGER #9 (TYP 5)
3" U-BOLT w/ LARGE WASHERS & NUTS
SLOT TOP PART OF ANGLE AS SHOWN
3x3x¼ ∠ IRON
1½x¼ CHANNEL
(2) 5/8" HOLES
WHITE/YELLOW MAIN
YELLOW/ORANGE
WHITE/YELLOW
HANG FIRE MAIN @ 15'-0" OC
DCPP
MAR 30 1987
MASTER FILE
PG&E
CIVIL - HYDRO CONST.
OFF. & SERVICE CENTERS



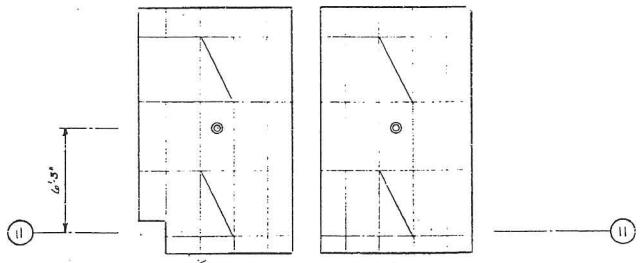
MEN'S & WOMEN'S REFLECTED CEILING PLAN
SCALE: 1/4" = 1'-0"



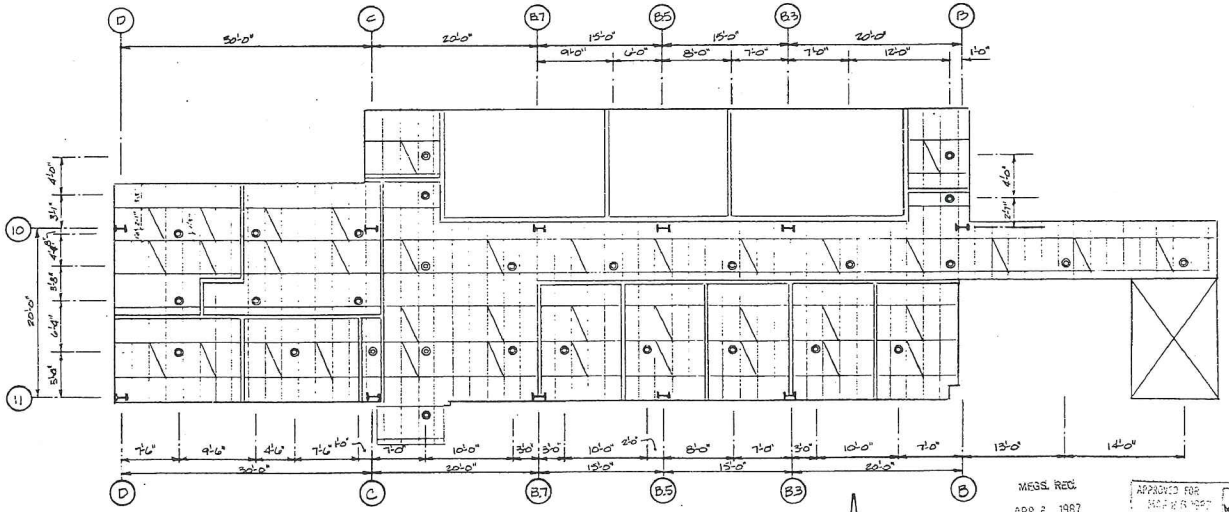
ENGINEERS' AREA REFLECTED CEILING PLAN
SCALE: 1/8" = 1'-0"

UPPER FLOOR

PLAN NORTH



MEN'S & WOMEN'S REFLECTED CEILING PLAN
SCALE: 1/4" = 1'-0"



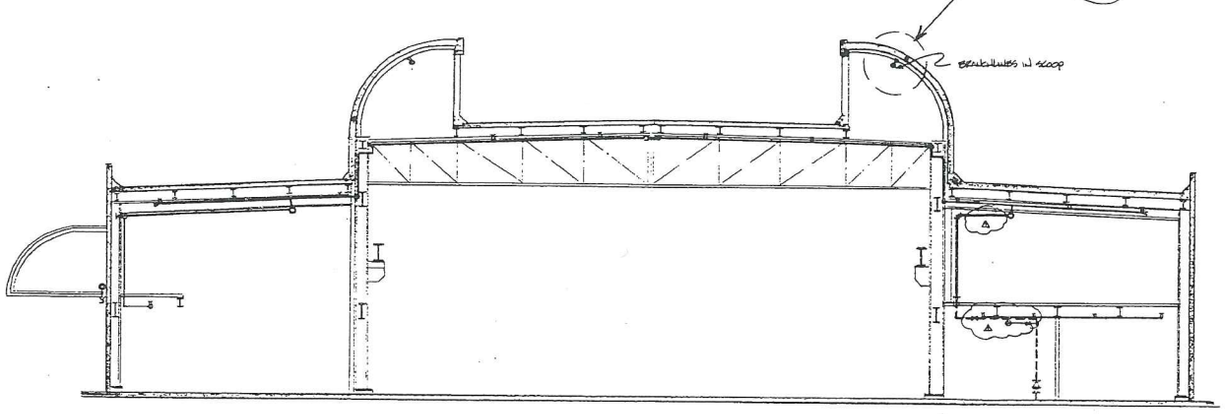
FOREMEN'S AREA REFLECTED CEILING PLAN
SCALE: 1/8" = 1'-0"

MEGS. REC.
APR 8 1987

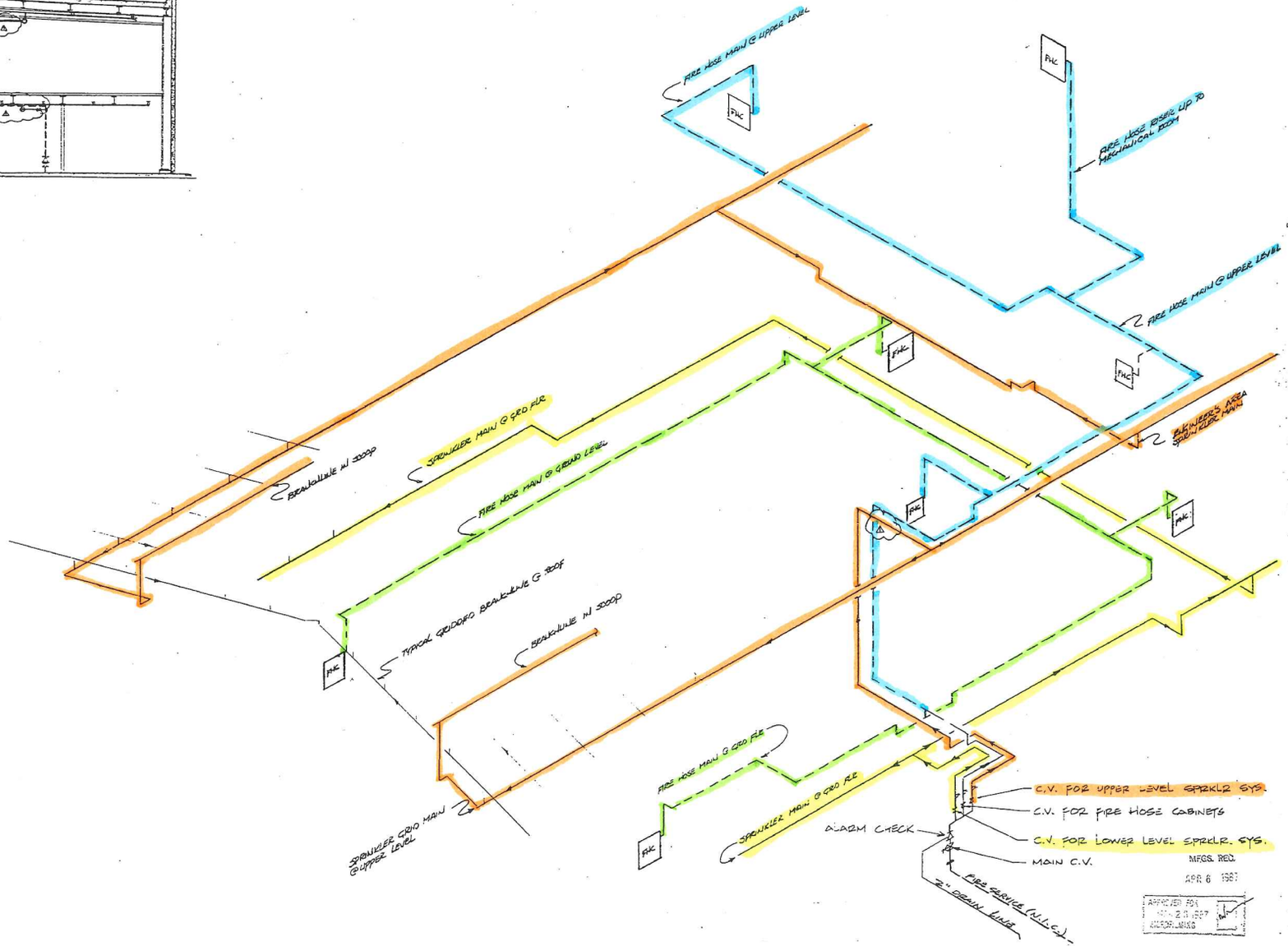
GROUND FLOOR

APPROVED FOR MICROFILMING

As Built
Date 12-3-86
By
Quality Fire Protection, Inc.



BUILDING SECTION A-A
SCALE: 1/8"=1'-0"



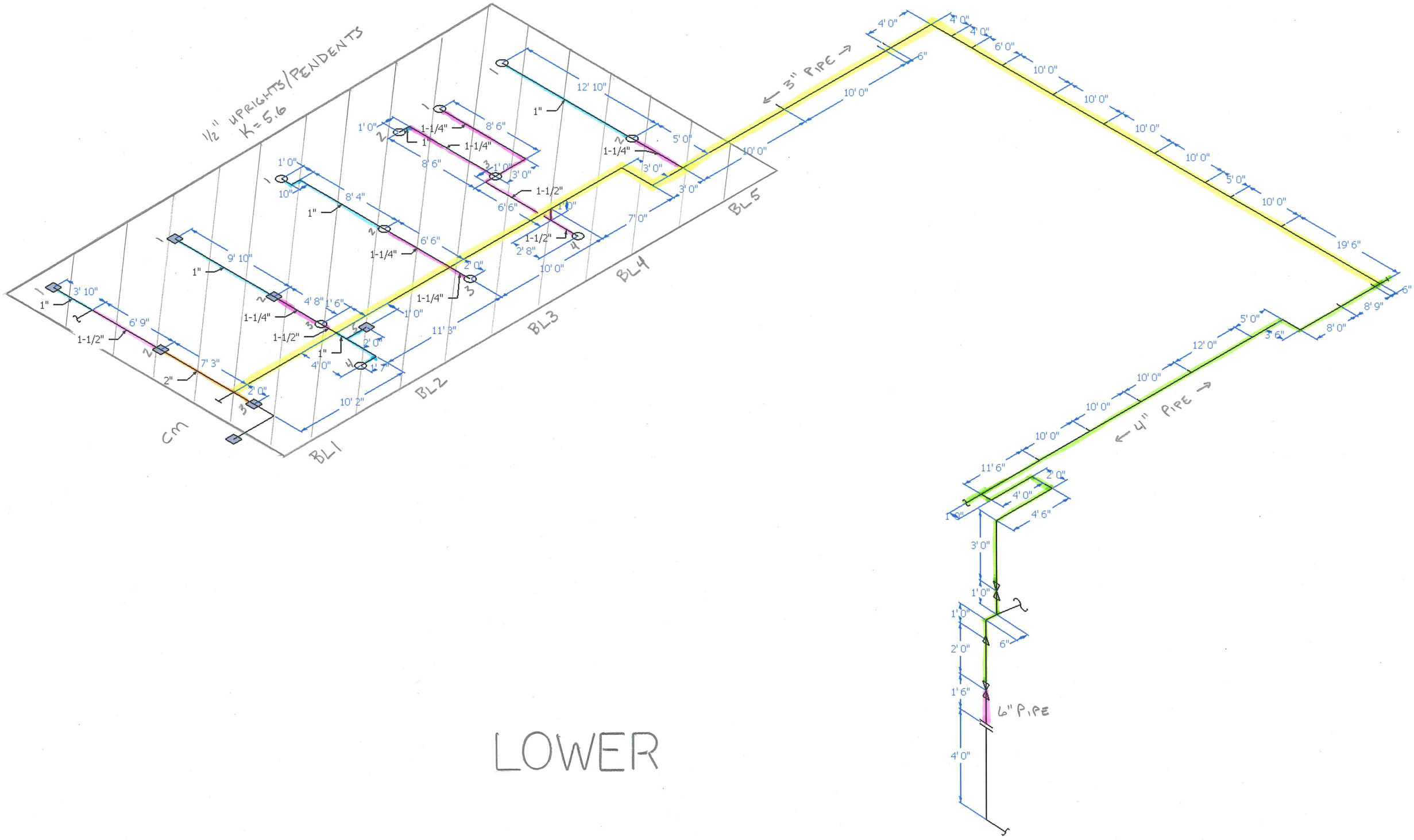
Appendix F: Overview Layout

REDACTED

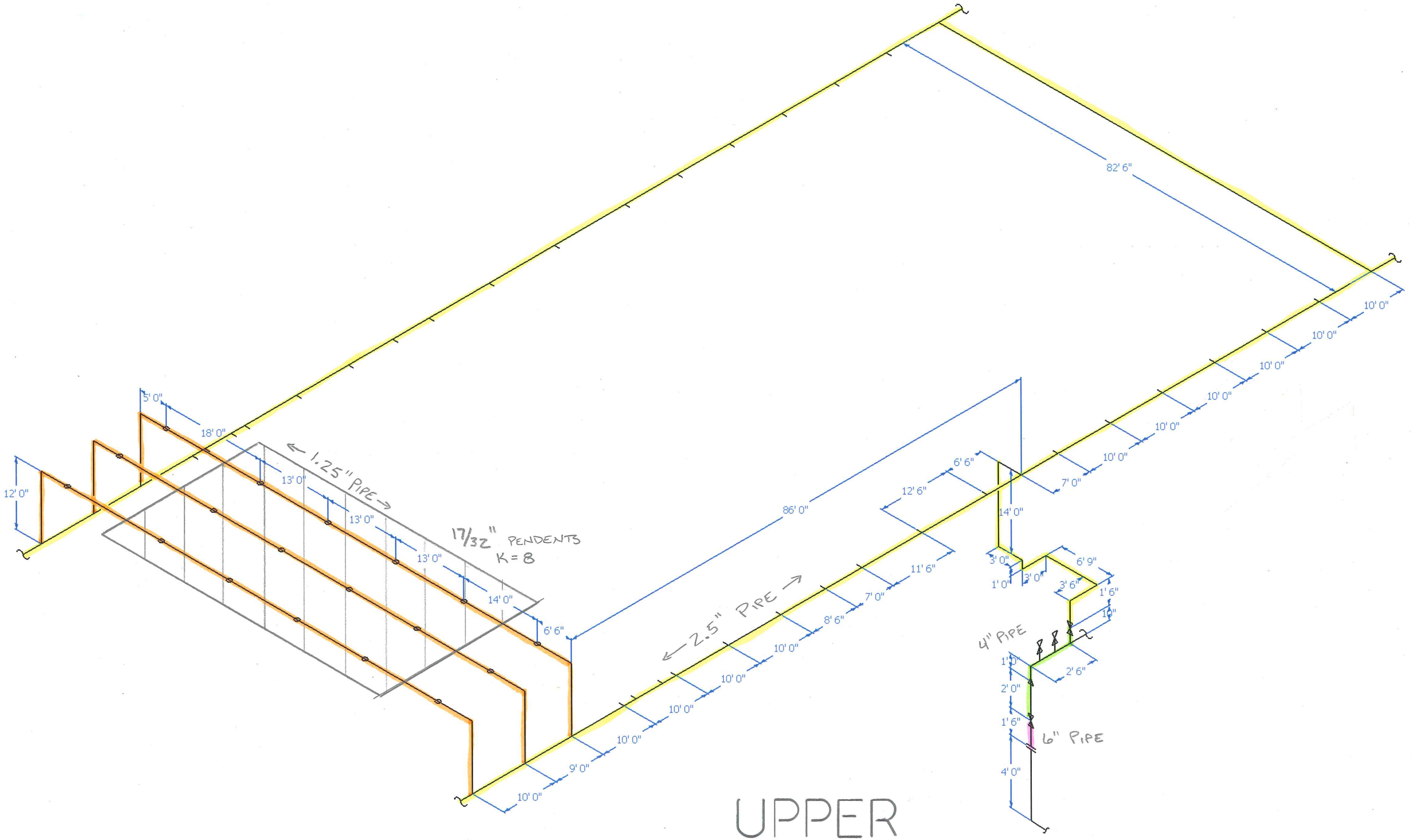
Appendix G: Hydrant Tests

REDACTED

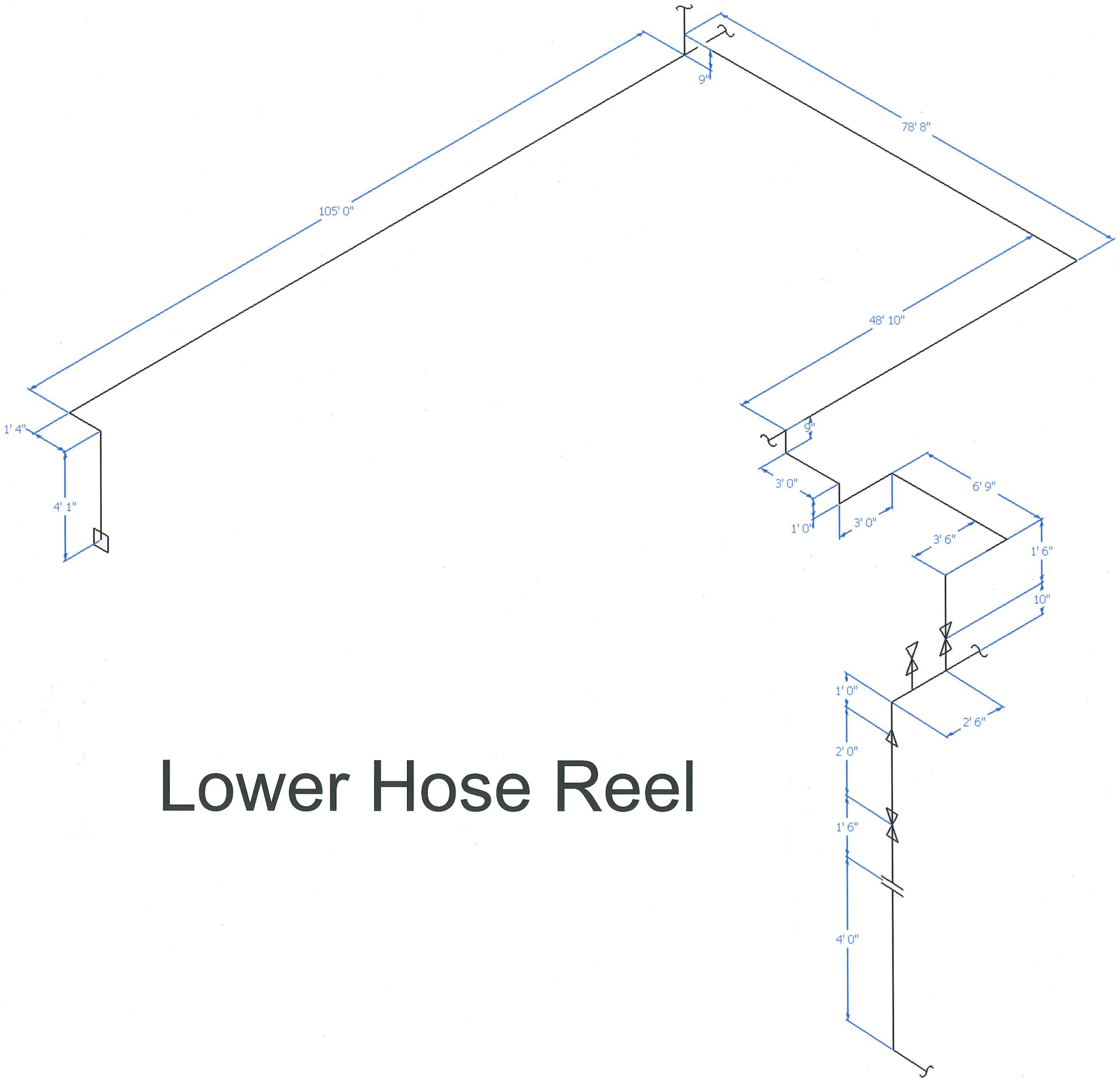
Appendix H: Piping Isometrics


1/2" UPRIGHTS/PENDENTS
K=5.6
3" PIPE
4" PIPE
6" PIPE
BL1
BL2
BL3
BL4
BL5
CM

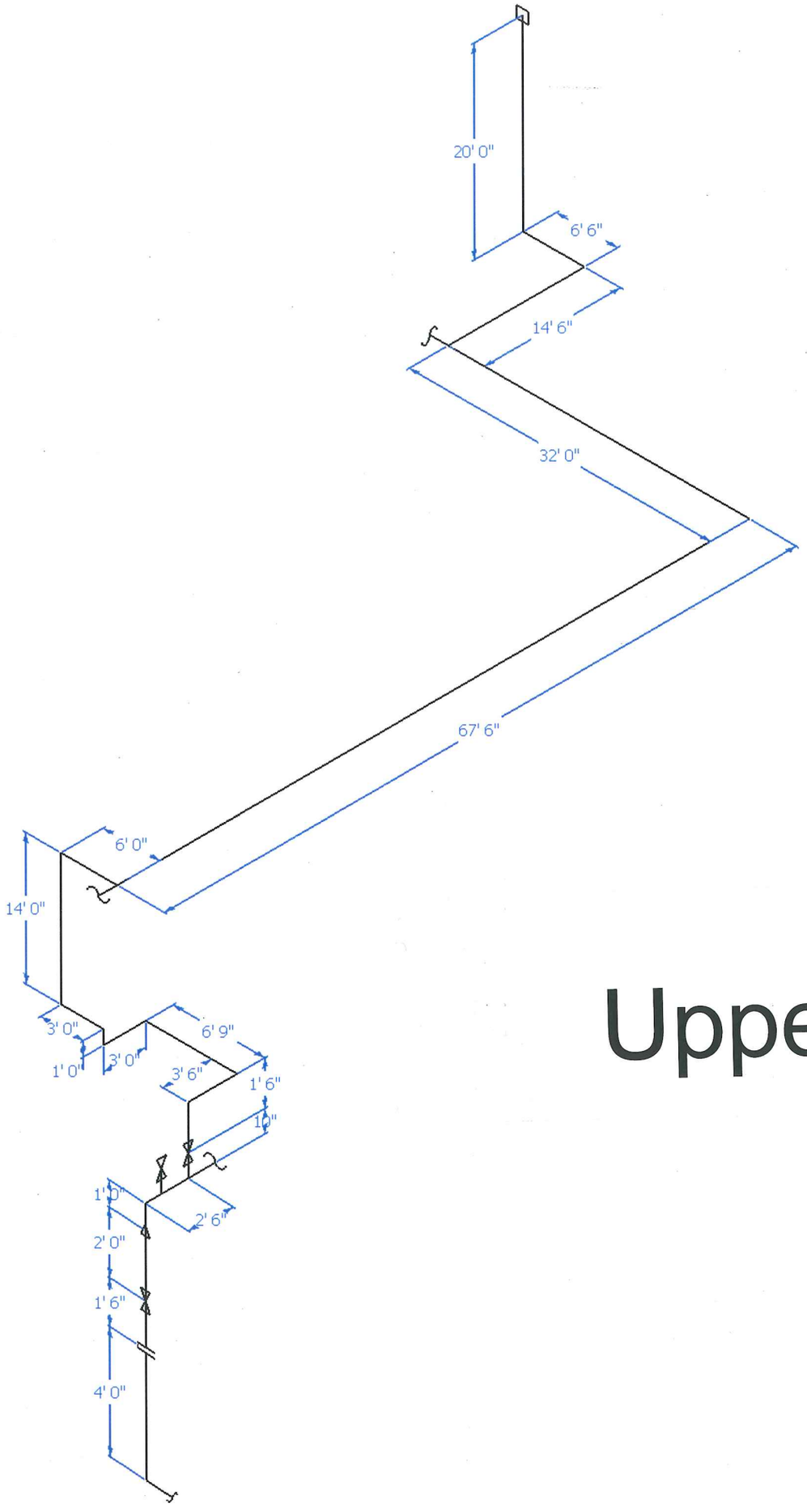
LOWER


82' 6"
10' 0"
10' 0"
10' 0"
10' 0"
10' 0"
10' 0"
10' 0"
10' 0"
10' 0"
9' 0"
10' 0"
86' 0"
5' 0"
18' 0"
13' 0"
13' 0"
13' 0"
14' 0"
6' 6"
12' 0"
← 1.25" PIPE →
17/32" PENDENTS
K = 8
← 2.5" PIPE →
12' 6"
11' 6"
7' 0"
8' 6"
6' 6"
7' 0"
14' 0"
3' 0"
1' 0"
3' 0"
6' 9"
3' 6"
1' 6"
1' 6"
4" PIPE
1' 0"
2' 6"
2' 0"
1' 6"
6" PIPE
4' 0"

UPPER



Lower Hose Reel



Upper Hose Reel

Appendix I: Manual Hydraulic Calculations

Steel Pipes Dimensions - ANSI Schedule 40

Internal and external diameters, areas, weights, volumes and number of threads for schedule 40 steel pipes

Based on ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

Pipe Size *(in)*	Diameter *(in)*		Nominal Thickness *(in)*	Transverse Areas *(in^2)*			Length of Pipe *(per sq. foot of)*		Volume *(ft^3/ft)*	Weight		Number of Threads per inch of Screw
	External	Internal		External	Internal	Steel	External Surface *(ft)*	Internal Surface *(ft)*		*lb/ft*	*kg/m*	
1/8	0.41	0.27	0.07	0.13	0.06	0.07	9.43	14.20	0.0004	0.24	0.36	27
¼	0.54	0.36	0.09	0.23	0.10	0.13	7.07	10.49	0.0007	0.42	0.63	18
3/8	0.68	0.49	0.09	0.36	0.19	0.17	5.66	7.75	0.0013	0.57	0.84	18
½	0.84	0.62	0.11	0.55	0.30	0.25	4.55	6.14	0.0021	0.85	1.26	14
¾	1.05	0.82	0.11	0.87	0.53	0.33	3.64	4.64	0.0037	1.13	1.68	14
1	1.32	1.05	0.13	1.36	0.86	0.49	2.90	3.64	0.0060	1.68	2.50	11 ½
1 ¼	1.66	1.38	0.14	2.16	1.50	0.67	2.30	2.77	0.0104	2.27	3.38	11 ½
1 ½	1.90	1.61	0.15	2.84	2.04	0.80	2.01	2.37	0.0141	2.72	4.04	11 ½
2	2.38	2.07	0.15	4.43	3.36	1.08	1.61	1.85	0.0233	3.65	5.43	11 ½
2 ½	2.88	2.47	0.20	6.49	4.79	1.70	1.33	1.55	0.0333	5.79	8.62	8
3	3.50	3.07	0.22	9.62	7.39	2.23	1.09	1.25	0.0513	7.58	11.27	8
3 ½	4.00	3.55	0.23	12.56	9.89	2.68	0.95	1.08	0.0687	9.11	13.56	8
4	4.50	4.03	0.24	15.90	12.73	3.17	0.85	0.95	0.0884	10.79	16.06	8
5	5.56	5.05	0.26	24.30	20.00	4.30	0.69	0.76	0.1389	14.61	21.74	8
6	6.63	6.07	0.28	34.47	28.89	5.58	0.58	0.63	0.2006	18.97	28.23	8
8	8.63	7.98	0.32	58.42	50.02	8.40	0.44	0.48	0.3552	28.55	42.49	8
10	10.75	10.02	0.37	90.76	78.85	11.90	0.36	0.38	0.5476	40.48	60.24	8
12	12.75	11.94	0.41	127.64	111.90	15.74	0.30	0.32	0.7763	53.60	79.77	8
14	14.00	13.13	0.44	153.94	135.30	18.64	0.27	0.28	0.9354	63.00	93.75	8
16	16.00	15.00	0.50	201.05	176.70	24.35	0.24	0.25	1.2230	78.00	116.08	8
18	18.00	16.88	0.56	254.85	224.00	30.85	0.21	0.23	1.5550	105.00	156.26	8
20	20.00	18.81	0.59	314.15	278.00	36.15	0.19	0.20	1.9260	123.00	183.05	8
24	24.00	22.63	0.69	452.40	402.10	50.30	0.16	0.17	2.7930	171.00	254.48	8

ASTM A53 pipe - also referred to as ASME SA53 pipe - is intended for mechanical and pressure applications. Can be used in steam, water, gas and air lines. Suitable for welding and forming like coiling, bending and flanging.

Project name: FPE 523 Final Project — Date: 3/13/2015

Step No.	Nozzle Ident and Location	Flow (gpm)	Pipe size (inches)	Pipe Fittings and Devices	Equivalent Pipe Length	Friction loss (psi/ft)	Pressure Summary (psi)	Normal Pressure	Notes	
1	Nozzle 1 BL1	q 16.8	1.05		L 3.83	C= 120	Pt 9.0	Pt	k = 5.6	
					F		Pe	Pv	q = k * (Pt)^1/2	
		Q 16.8			T 3.83	pf 0.093	Pf 0.4	Pn	Pt = (q / k)^2 = 8.96	
2	Nozzle 2 BL1	q 17.1	1.61		L 6.75	C= 120	Pt 9.3	Pt	k = 5.6	
					F		Pe	Pv		
		Q 33.9			T 6.75	pf 0.043	Pf 0.3	Pn		
3	Nozzle 3 BL1	q 17.4	2.07	1 Cross @ 15'	L 7.25	C= 120	Pt 9.6	Pt	k = 5.6	
					F 15		Pe	Pv		
		Q 51.2			T 22.25	pf 0.027	Pf 0.6	Pn		
4	BL1 East	q 0.0			L	C=	Pt 10.2	Pt		
					F		Pe	Pv	Pt = 10.2	
		Q 51.2			T	pf	Pf	Pn	Qt = 51.2	
5	Nozzle 4 BL1	q 16.8	2.07	1 Cross @ 15'	L 2.83	C= 120	Pt 9.0	Pt	k = 5.6	
					F 15		Pe	Pv	Pt = 9.1	
		Q 16.8			T 17.83	pf 0.003	Pf 0.1	Pn	Qt = 16.8	
6	BL1 Total	q 0.0			L	C=	Pt 9.1	Pt	BL1	
					F		Pe	Pv	Pt = 19.4	10.2 + 9.1
		Q 68.0			T	pf	Pf 19.3	Pn	Qt = 68.0	51.2 + 16.8
7	BL1 to BL2	q 0.0	3.07		L 10.17	C= 120	Pt 19.3	Pt	k = 5.6	
					F		Pe	Pv		
		Q 68.0			T 10.17	pf 0.007	Pf 0.1	Pn		
8	Nozzle 1 BL2	q 16.8	1.05		L 9.83	C= 120	Pt 9.0	Pt	k = 5.6	
					F		Pe	Pv		
		Q 16.8			T 9.83	pf 0.094	Pf 0.9	Pn		
9	Nozzle 2 BL2	q 17.6	1.38		L 4.67	C= 120	Pt 9.9	Pt	k = 5.6	
					F		Pe	Pv		
		Q 34.4			T 4.67	pf 0.094	Pf 0.4	Pn		
10	Nozzle 3 BL2	q 18.0	1.61	1 Cross @ 15'	L 1.5	C= 120	Pt 10.4	Pt	k = 5.6	
					F 15		Pe	Pv		
		Q 52.5			T 16.5	pf 0.096	Pf 1.6	Pn		
11	BL2 East	q			L	C=	Pt 11.9	Pt		
					F		Pe	Pv	Pt = 11.9	
		Q 52.5			T	pf	Pf	Pn	Qt = 52.5	
12	Nozzle 4 BL2	q 16.8	1.05	1 Elbow @ 1'	L 6.5	C= 120	Pt 9.0	Pt	k = 5.6	
					F 1		Pe	Pv		
		Q 16.8			T 7.5	pf 0.094	Pf 0.7	Pn		
13	Nozzle 5 BL2	q 17.4	1.05	1 Cross @ 15'	L 1	C= 120	Pt 9.7	Pt	k = 5.6	
					F 15		Pe	Pv	Pt = 15.3	
		Q 34.2			T 16	pf 0.350	Pf 5.6	Pn	Qt = 34.2	
14	BL2 Total	q			L	C=	Pt 15.3	Pt	BL2	
					F		Pe	Pv	Pt = 27.2	11.9 + 15.3
		Q 86.7			T	pf	Pf	Pn	Qt = 86.7	52.5 + 34.2
15	BL2 to BL3	q 0.0	3.07		L 11.25	C= 120	Pt 46.6	Pt		
					F		Pe	Pv	Pt = 46.6	19.4 + 27.2
		Q 154.7			T 11.25	pf 0.031	Pf 0.3	Pn	Qt = 154.7	68 + 86.7
16	Nozzle 1 BL3	q 16.8	1.05	2 Elbow @ 1'	L 10.17	C= 120	Pt 9.0	Pt	k = 5.6	
					F 2		Pe	Pv		
		Q 16.8			T 12.17	pf 0.094	Pf 1.1	Pn		
17	Nozzle 2 BL3	q 17.8	1.38	1 Cross @ 15'	L 6.5	C= 120	Pt 10.1	Pt	k = 5.6	
					F 15		Pe	Pv		
		Q 34.6			T 21.5	pf 0.095	Pf 2.0	Pn		
18	BL3 East	q			L	C=	Pt 12.2	Pt		
					F		Pe	Pv	Pt = 12.2	
		Q 34.6			T	pf	Pf 0.0	Pn	Qt = 34.6	
19	Nozzle 3 BL3	q 16.8	1.38	1 Cross @ 15'	L 2	C= 120	Pt 9.0	Pt	k = 5.6	
					F 15		Pe	Pv	Pt = 12.3	
		Q 16.8			T 17	pf 0.025	Pf 0.4	Pn	Qt = 16.8	
20	BL3 Total	q			L	C=	Pt 9.4	Pt	BL3	
					F		Pe	Pv	Pt = 24.5	12.2 + 12.3
		Q 51.4			T	pf	Pf 0.0	Pn	Qt = 51.4	34.6 + 16.8
21	BL3 to BL4	q 0.0	3.07	1 Cross @ 15'	L 1	C= 120	Pt 71.1	Pt		
					F 15		Pe	Pv	Pt = 71.1	46.6 + 24.5
		Q 206.1			T 16	pf 0.052	Pf 0.8	Pn	Qt = 206.1	154.7 + 51.4
22	Nozzle 1 BL4	q 16.8	1.38	1 Elbow @ 2'	L 8.5	C= 120	Pt 9.0	Pt	k = 5.6	
					F 2		Pe	Pv		
		Q 16.8			T 10.5	pf 0.025	Pf 0.3	Pn		
23		q 0.0	1.61		L 3	C= 120	Pt 9.3	Pt		
					F		Pe	Pv	Pt = 9.3	
		Q 16.8			T 3	pf 0.012	Pf 0.0	Pn	Qt = 16.8	
24	Nozzle 2 BL4	q 16.8	1.05	1 Elbow @ 2'	L 1	C= 120	Pt 9.0	Pt	k = 5.6	
					F 2		Pe	Pv		
		Q 16.8			T 3	pf 0.094	Pf 0.3	Pn		
25		q 0.0	1.38	1 Tee @ 8'	L 8.5	C= 120	Pt 9.3	Pt		
					F 8		Pe	Pv	Pt = 9.7	
		Q 16.8			T 16.5	pf 0.025	Pf 0.4	Pn	Qt = 16.8	
26	Nozzle 3 BL4	q 24.4	1.61	1 Elbow @ 8' 1 Cross @ 15'	L 9.5	C= 120	Pt 19.0	Pt	k = 5.6	
					F 23		Pe	Pv	Pt = 19	9.3 + 9.7
		Q 41.2			T 32.5	pf 0.062	Pf 2.0	Pn	Qt = 41.2	16.8 + 16.8 + 24.4
27	BL4 East	q 0.0			L	C=	Pt 21.0	Pt		
					F		Pe	Pv	Pt = 21	
		Q 41.2			T	pf	Pf 0.0	Pn	Qt = 41.2	
28	Nozzle 4 BL4	q 16.8	1.61	1 Cross @ 15'	L 2.67	C= 120	Pt 9.0	Pt	k = 5.6	
					F 15		Pe	Pv		
		Q 16.8			T 17.67	pf 0.012	Pf 0.2	Pn		
29	BL4 Total	q			L	C=	Pt 9.2	Pt	BL4	
					F		Pe	Pv	Pt = 30.2	21 + 9.2
		Q 58.0			T	pf	Pf 30.2	Pn	QT = 58.0	41.2 + 16.8
30	BL4 to BL5	q 0.0	3.07	2 Elbow @ 7' 1 Tee @ 15'	L 13	C= 120	Pt 101.3	Pt		
					F 29		Pe	Pv	Pt = 101.3	71.1 + 30.2
		Q 264.1			T 42	pf 0.083	Pf 3.5	Pn	Qt = 264.1	206.1 + 58
31	Nozzle 1 BL5	q 16.8	1.05		L 12.83	C= 120	Pt 9.0	Pt	k = 5.6	
					F		Pe	Pv		
		Q 16.8			T 12.83	pf 0.094	Pf 1.2	Pn		
32	Nozzle 2 BL5	q 17.9	1.38	1 Tee @ 7'	L 5	C= 120	Pt 10.2	Pt	k = 5.6	
					F 7		Pe	Pv	Pt = 11.3	
		Q 34.7			T 12	pf 0.095	Pf 1.1	Pn	Qt = 34.7	
33	BL5 to 4" CM	q 0.0	3.07	1 Elbow @ 7' 1 Tee @ 20'	L 95	C= 120	Pt 112.6	Pt		
					F 27		Pe	Pv	Pt = 112.6	101.3 + 11.3
		Q 298.8			T 122	pf 0.104	Pf 12.6	Pn	Qt = 298.8	264.1 + 34.7
34	4" CM to 6" Gate	q 0.0	4.026	7 Elbow @ 10' 2 Tee @ 20' Gate @ 2' Check @ 22'	L 118.8	C= 120	Pt 125.3	Pt		
					F 55		Pe 3.0	Pv	Pe = 7 x .433	
		Q 298.8			T 173.8	pf 0.028	Pf 4.8	Pn		
35		q 0.0	6.065		L 1.5	C= 120	Pt 133.1	Pt		
					F		Pe 0.7	Pv	Pe = 1.5 x .433	
		Q 298.8			T 1.5	pf 0.004	Pf 0.0	Pn		
36		q 0.0	7.98		L 4	C= 100	Pt 133.8	Pt		
					F		Pe 1.7	Pv	Pe = 4 x .433	
		Q 298.8			T 4	pf 0.001	Pf 0.0	Pn		
37		q 0.0			L	C= 120	Pt 135.5	Pt	K(Total) =	Q_T/(P_BOR)^.5
					F		Pe	Pv	K(Total) =	298.8/(135.5)^.5
		Q 298.8			T	pf	Pf	Pn	K(Total) =	25.7

Project name:		FPE 523 Final Project														Date:	3/19/2015
Step No.	Nozzle Ident and Location	Flow (gpm)		Pipe size (inches)	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary (psi)		Normal Pressure		Notes			
1	Nozzle 1 BL1	q	24.7	1.38		L	13	C=	120	Pt	9.5	Pt		k =	8		
						F				Pe		Pv		q =	k * (Pt)^1/2		
		Q	24.7			T	13	pf	0.050	Pf	0.7	Pn		Pt =	(q / k)^2 = 9.5		
2	Nozzle 2 BL1	q	25.5	1.38		L	13	C=	120	Pt	10.2	Pt		k =	8		
						F				Pe		Pv		q =	8 x (10.2)^1/2		
		Q	50.2			T	13	pf	0.187	Pf	2.4	Pn					
3	Nozzle 3 BL1	q	28.4	1.38		L	13	C=	120	Pt	12.6	Pt		k =	8		
						F				Pe		Pv		q =	8 x (12.6)^1/2		
		Q	78.5			T	13	pf	0.430	Pf	5.6	Pn					
4	Nozzle 4 BL1	q	34.1	1.38	1 Elbow @ 3' 1 Tee @ 12'	L	32.5	C=	120	Pt	18.2	Pt		k =	8		
						F	15			Pe	5.2	Pv		q =	8 x (18.2)^1/2		
		Q	112.7			T	47.5	pf	0.838	Pf	39.8	Pn		Pe =	12 x .433		
6	CM1 BL1 to BL2	q	0.0	2.469		L	10	C=	120	Pt	63.2	Pt		K(BL1) =	Q_T/(P_BOR)^.5		
						F				Pe		Pv		K(BL1) =	112.7/(63.2)^.5		
		Q	112.7			T	10	pf	0.049	Pf	0.5	Pn		K(BL1) =	14.2		
7	CM1 BL2	q	113.1	2.469		L	9	C=	120	Pt	63.7	Pt		q =	14.2 x 63.7^.5		
						F				Pe		Pv					
		Q	225.7			T	9	pf	0.178	Pf	1.6	Pn					
8	CM1 BL2 to BL3	q	114.5	2.469	7 Elbows @ 6' 1 Tee @ 12' Gate Valve @ 1'	L	118.75	C=	120	Pt	65.3	Pt		q =	14.2 x 65.3^.5		
						F	55			Pe	7.1	Pv		Pe =	16.5 x .433		
		Q	340.3			T	173.75	pf	0.381	Pf	66.2	Pn					
12	2.5" Gate to 6" Gate	q	0.0	4.026	2 Elbow @ 10' Check Valve @ 22' Gate Valve @ 3'	L	6.5	C=	120	Pt	138.6	Pt					
						F	85			Pe	1.7	Pv		Pe =	4 x .433		
		Q	340.3			T	91.5	pf	0.035	Pf	3.2	Pn					
13	6" Gate to 8" Reduce	q	0.0	6.065		L	1.5	C=	120	Pt	143.6	Pt					
						F				Pe	0.7	Pv		Pe =	1.5 x .433		
		Q	340.3			T	1.5	pf	0.005	Pf	0.0	Pn					
14	8" Reduce to BOR	q	0.0	7.98		L	4	C=	100	Pt	144.2	Pt					
						F				Pe	1.7	Pv		Pe =	4 x .433		
		Q	340.3			T	4	pf	0.002	Pf	0.0	Pn					
15		q	0.0			L		C=	120	Pt	146.0	Pt		K(Tot) =	Q_T/(P_BOR)^.5		
						F				Pe		Pv		K(Tot) =	340.3/(146)^.5		
		Q	340.3			T		pf		Pf		Pn		K(Tot) =	28.2		

UPPER

Project name:	FPE 523 Final Project													Date: 3/19/2015	
Step No.	Nozzle Ident and Location	Flow (gpm)		Pipe size (inches)	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary (psi)		Normal Pressure		Notes	
1	Hose Reel to 4" Gate Valve	q	250.0	4.026	7 Elbow @ 10' 3 Tee @ 20' Gate Valve @ 2'	L	254.3	C=	120	Pt	100.0	Pt		Pe =	4 x .433
						F	132			Pe	1.732	Pv			
		Q	250.0			T	386.3	pf	0.020	Pf	7.7	Pn			
3	4" Gate to 6" Gate	q	0.0	4.026	1 Elbow @ 10' 1 Tee @ 20' Check Valve @ 22'	L	6.5	C=	120	Pt	109.4	Pt		Pe =	4 x .433
						F	52			Pe	1.7	Pv			
		Q	250.0			T	58.5	pf	0.020	Pf	1.2	Pn			
4	6" Gate to 8" Reduce	q	0.0	6.065		L	1.5	C=	120	Pt	112.3	Pt		Pe =	1.5 x .433
						F				Pe	0.7	Pv			
		Q	250.0			T	1.5	pf	0.003	Pf	0.0	Pn			
5	8" Reduce to BOR	q	0.0	7.98		L	4	C=	100	Pt	113.0	Pt		Pe =	4 x .433
						F				Pe	1.7	Pv			
		Q	250.0			T	4	pf	0.001	Pf	0.0	Pn			
6		q	0.0			L		C=		Pt	114.7	Pt		K(Tot) =	Q_T/(P_BOR)^.5
						F				Pe		Pv		K(Tot) =	250/(114.7)^.5 = 23
		Q	250.0			T		pf		Pf		Pn		K(Tot) =	23

LOWER HOSE

Project name:		FPE 523 Final Project													Date: 3/19/2015	
Step No.	Nozzle Ident and Location	Flow (gpm)		Pipe size (inches)	Pipe Fittings and Devices	Equivalent Pipe Length		Friction loss (psi/ft)		Pressure Summary (psi)		Normal Pressure			Notes	
1	Hose Reel 3" Run to 4" Run	q Q	250.0 250.0	3.07		L F T	20 7 27	C= pf	120 0.075	Pt Pe Pf	100.0 8.66 2.0	Pt Pv Pn			Pe =	20 x .433
2	4" Run to 4" Gate Valve	q Q	0.0 250.0	4.026	6 Elbow @ 10' 2 Tee @ 20' Gate Valve @ 2'	L F T	160 102 262	C= pf	120 0.020	Pt Pe Pf	110.7 7.1 5.2	Pt Pv Pn			Pe =	16.5 x .433
3	4" Gate to 6" Gate	q Q	0.0 250.0	4.026	1 Elbow @ 10' 1 Tee @ 20' Check Valve @ 22'	L F T	6.5 52 58.5	C= pf	120 0.020	Pt Pe Pf	123.0 1.7 1.2	Pt Pv Pn			Pe =	4 x .433
4	6" Gate to 8" Reduce	q Q	0.0 250.0	6.065		L F T	1.5 1.5	C= pf	120 0.003	Pt Pe Pf	125.9 0.7 0.0	Pt Pv Pn			Pe =	1.5 x .433
5	8" Reduce to BOR	q Q	0.0 250.0	7.98		L F T	4 4	C= pf	100 0.001	Pt Pe Pf	126.5 1.7 0.0	Pt Pv Pn			Pe =	4 x .433
6		q Q	0.0 250.0			L F T		C= pf		Pt Pe Pf	128.3 	Pt Pv Pn			K(Tot) = K(Tot) = K(Tot) =	Q_T/(P_BOR)^.5 250/(128.3)^.5 = 22 22

UPPER HOSE

Appendix J: AutoSPRINK Calculations

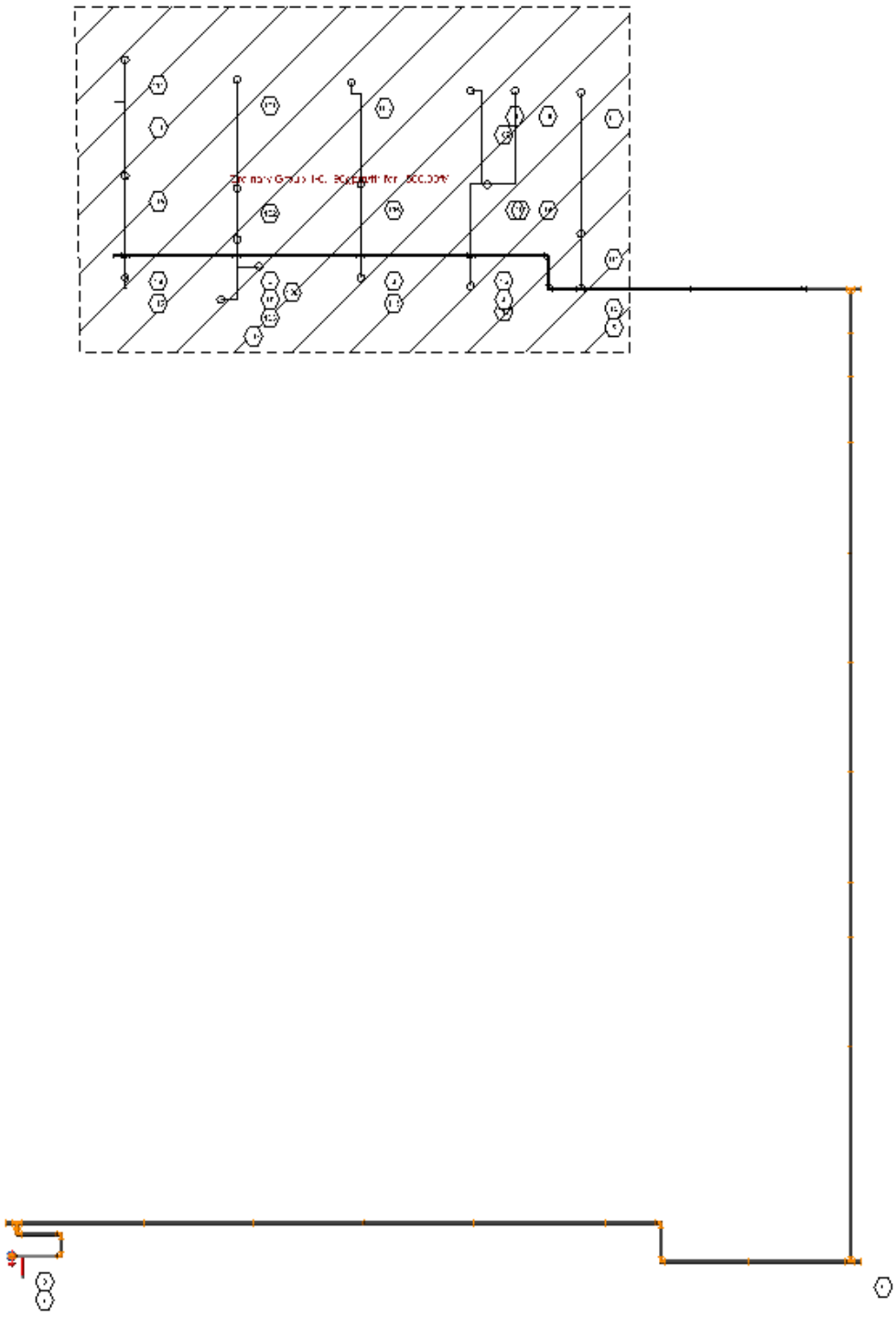


Figure 57: AutoSPRINK Lower System Layout

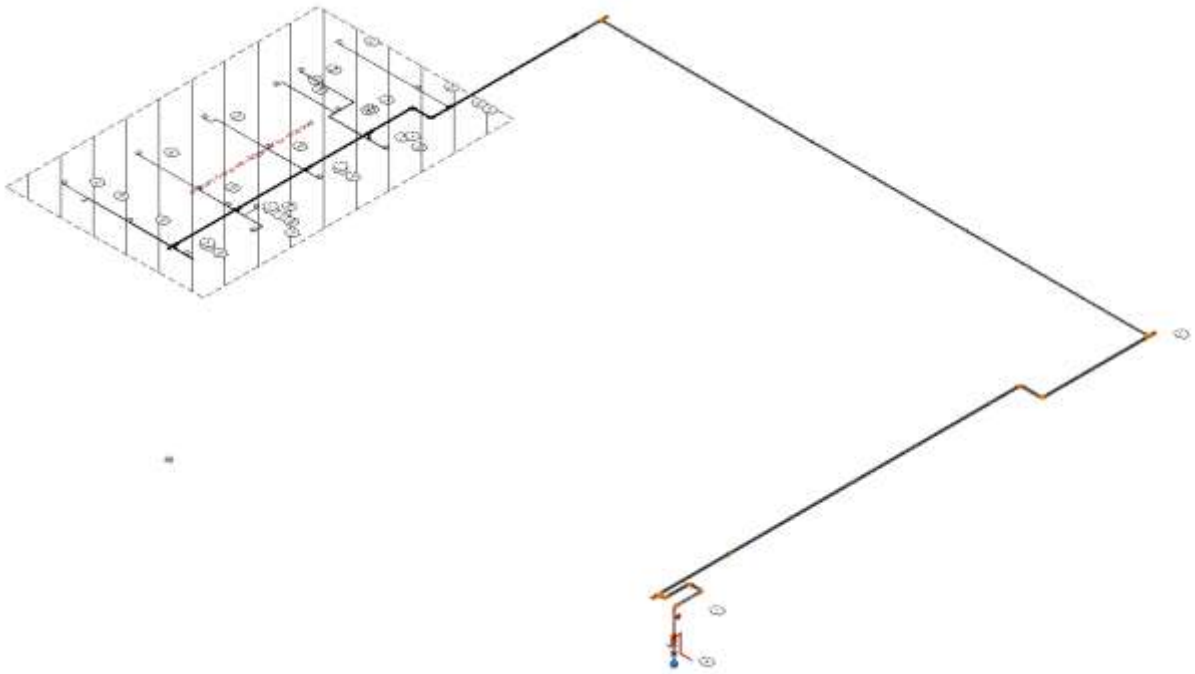


Figure 58: AutoSPRINK Lower System ISO

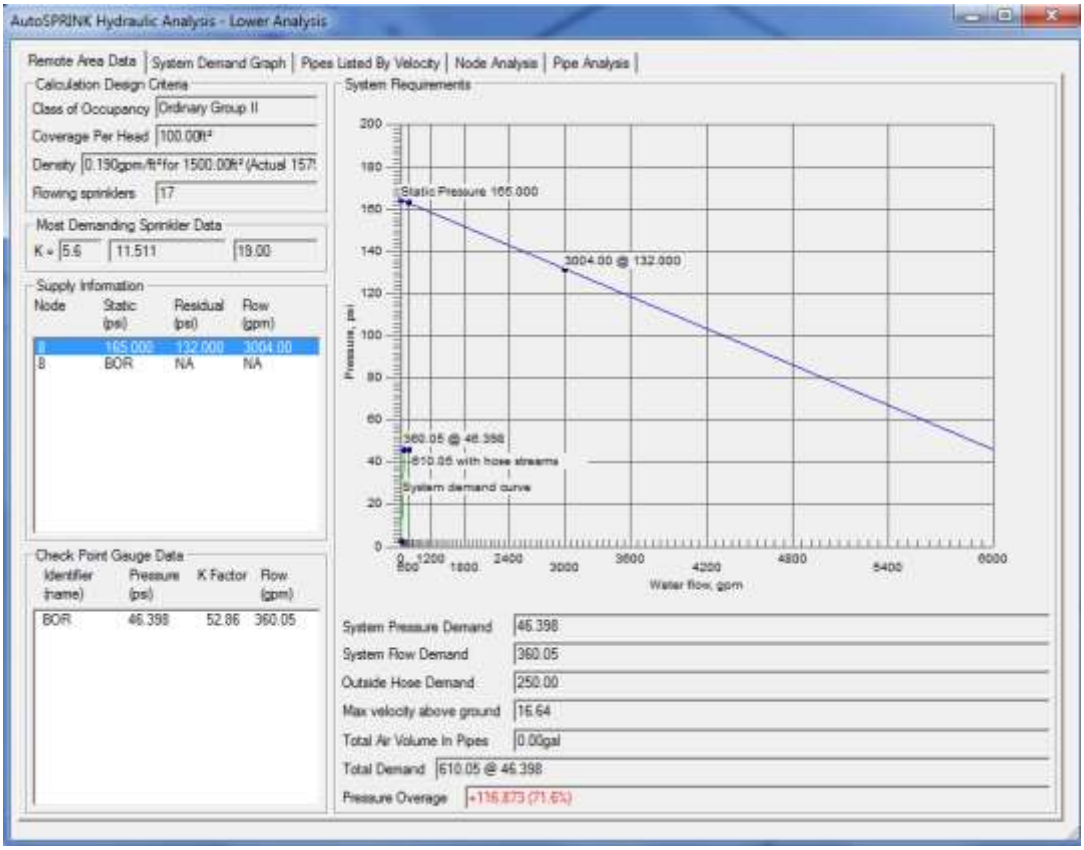


Figure 59: AutoSPRINK Lower System Calculation Results

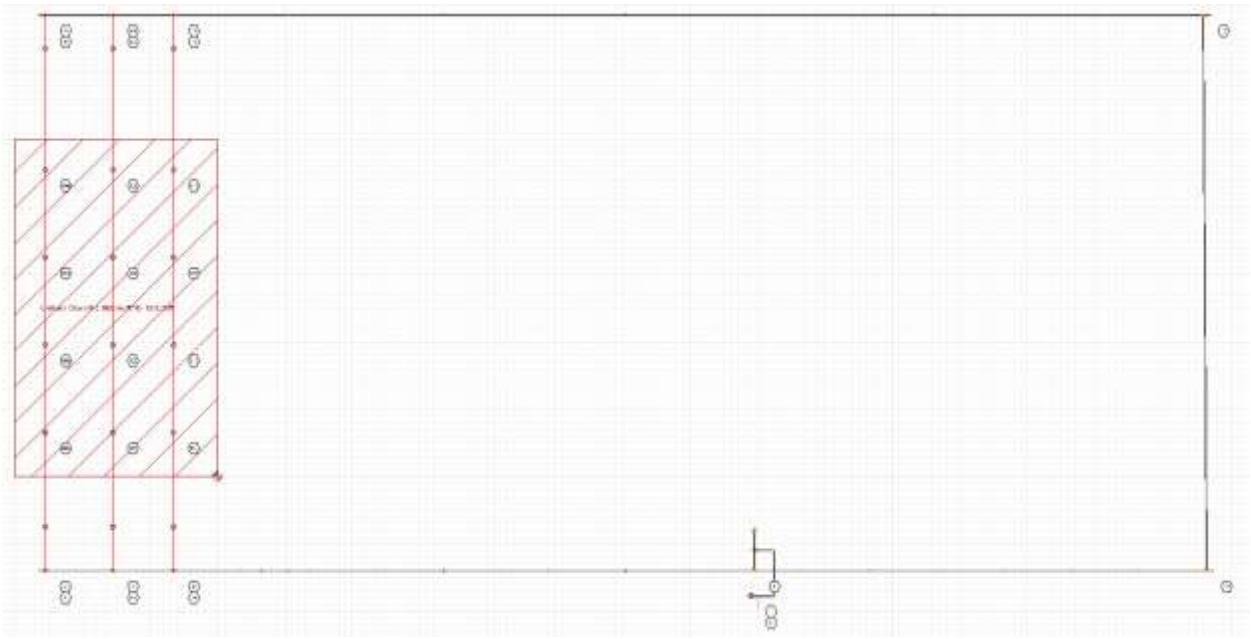


Figure 60: AutoSPRINK Upper System Layout

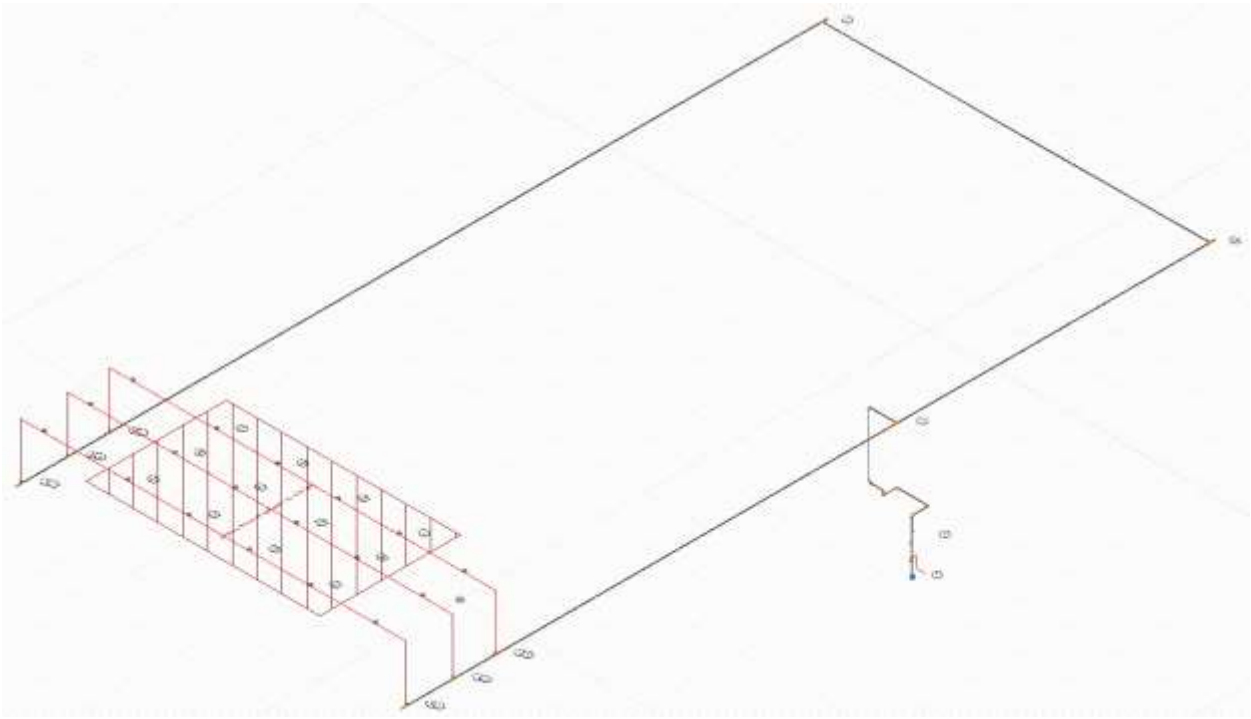


Figure 61: AutoSPRINK Upper System ISO

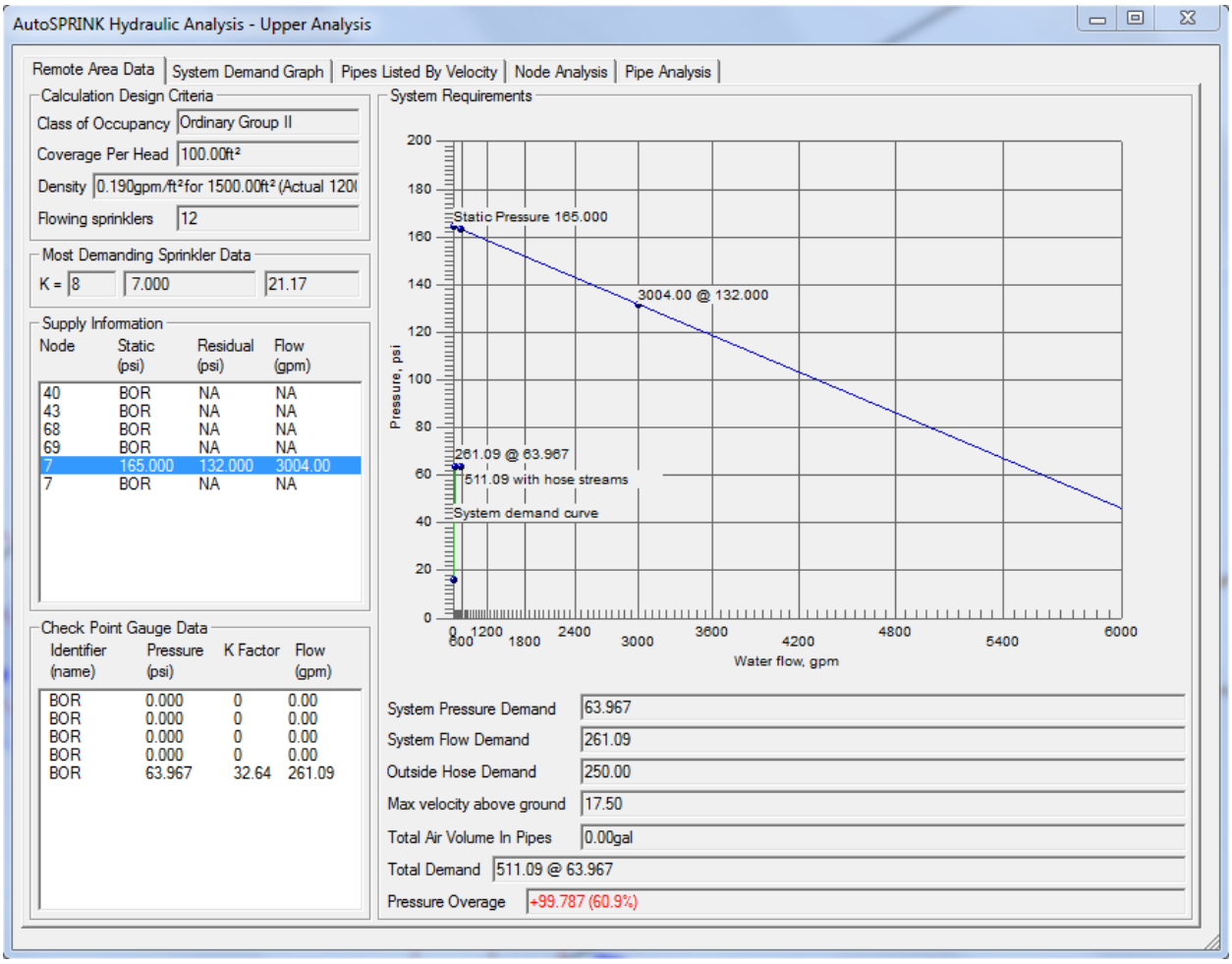


Figure 62: AutoSPRINK Upper System Calculation Results

Appendix K: Structural Drawing Markups

ABBREVIATIONS

&	AND
@	AT
⌀	DIAMETER
'	FOOT
"	INCH
#	NUMBER
±	PLUS OR MINUS

A

ABT	ABOUT
AC	AIR CONDITIONING
ACST	ACOUSTICAL
ADD.	ADDITION, ADDENDUM
AGGF	AGGREGATE
AL	ALUMINUM
ARCH.	ARCHITECTURAL
ASB	ASBESTOS
ASST	ASSISTANT

B

BD	BOARD
BET.	BETWEEN
BLDG	BUILDING
BLK	BLOCK
BLR	BOILER
BM	BEAM
B.O.S.	BOTTOM OF STEEL
BOT	BOTTOM

C

CAB.	CABINET
CALIB	CALIBRATION
CAT.	CATALOGUE
CEM	CEMENT
CHKR	CHECKER
℄	CENTER LINE
C.M.U.	CONCRETE MASONRY UNIT
CLG	CEILING
CLO	CLOSET
CO	COMPANY
COL	COLUMN
CONC	CONCRETE
CONF	CONFERENCE
CONST	CONSTRUCTION
CONT	CONTINUOUS
CORP	CORPORATION
CORR	CORRUGATED
CSK	COUNTERSINK

D

DEPT	DEPARTMENT
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIM.	DIMENSION
DF	DRINKING FOUNTAIN (ALSO SEE "EWC")
DN	DOWN
DR	DOOR
DS	DOWNSPOUT
DWG	DRAWING

E

E	EAST
EA	EACH
EL	ELEVATION
ELEC	ELECTRICAL
ELEV	ELEVATOR
EMER.	EMERGENCY
EQ	EQUAL
EQUIP.	EQUIPMENT
EVAP	EVAPORATOR
E.W.C.	ELECTRIC WATER COOLER
EXP	EXPANSION (JOINT)
EXT	EXTERIOR
EXH	EXHAUST

F

FD	FLOOR DRAIN
FDN	FOUNDATION
FH	FLAT HEAD
FHC	FIRE HOSE CABINET
FHMS	FLAT HEAD MACHINE SCREW
FIN.	FINISH
FL	FLOOR
F.O.B.	FREE ON BOARD
FT	FOOT

G

GA	GAGE OR GAUGE
GALV	GALVANIZED
GEN	GENERATOR
GI	GALVANIZED IRON
GL	GLASS
G.L.	GIRT LINE
GRD	GROUND
GYP.	GYPSUM
GYP. BD.	GYPSUM BOARD

H

H.B.	HOSE BIB
HDW	HARDWARE
HR	HAND RAIL
HEX.	HEXAGONAL
HGT	HEIGHT
HOR	HORIZONTAL
H/C	HANDICAP
HPT	HIGH POINT
HTR	HEATER
HVAC	HEATING, VENTILATING &

I

I.D.	INSIDE DIAMETER
IN.	INCH
INFO	INFORMATION
INS	INSULATION, INSULATED
INST	INSTRUMENT
INT	INTERIOR

J

JAN	JANITOR
JT	JOINT
JCT	JUNCTION

L

LAB	LABORATORY
LAV	LAVATORY
LB	POUND
LH	LEFT HAND
LHR	LEFT HAND REVERSE
LKR	LOCKER
LP	LOW POINT
LUBE	LUBRICATION
LVR	LOUVER

M

MACH	MACHINE
MAINT	MAINTENANCE
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MET	METAL
MEZZ	MEZZANINE
MFD	MANUFACTURED
MFG	MANUFACTURING
MFR'S	MANUFACTURER'S
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MK	MARK
MLP	METAL LATH & PLASTER
MO	MASONRY OPENING
M.T	METAL THRESHOLD

N

N	NORTH
N.I.C.	NOT IN CONTRACT
NO.	NUMBER
NOM	NOMINAL
NTS	NOT TO SCALE

O

OC	ON CENTER
OD	OUTSIDE DIAMETER
OFF.	OFFICE
OPNG	OPENING
OPP	OPPOSITE

P

P.C.	PRECAST PANEL
PEN.	PENETRATION
PL	PLATE
PLAS	PLASTER
PLATF	PLATFORM
PNL	PANEL
PREP	PREPARATION
PROJ	PROJECT
PST	PRESTRESSED
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PTN	PARTITION

R

R	RISER
R	RADIUS
RC	REINFORCED CONCRETE
RCVR	RECEIVER
RD	ROOF DRAIN
REF	REFERENCE
REFR	REFRIGERATOR
REINF	REINFORCED
REM	REMOVABLE
REQD	REQUIRED
REV	REVISION
RH	RIGHT HAND
RHMS	ROUND HEAD MACHINE SCREW
RHR	RIGHT HAND REVERSE
RM	ROOM
RO	ROUGH OPENING
RR	RAILROAD

S

S	SOUTH
SECT.	SECTION
SECY	SECRETARY
SHT	SHEET
SHO	SHOWER
SIM	SIMILAR
SK	SINK
SPEC	SPECIFICATION
SQ	SQUARE
SQ FT	SQUARE FOOT
SQ IN	SQUARE INCH
SS	SERVICE SINK
SST	STAINLESS STEEL
STD	STANDARD
ST.	STEEL
STC	STORAGE
STR	STRUCTURAL
SUPT	SUPERINTENDENT
SUPV	SUPERVISOR
SUSP	SUSPENDED
SWGR	SWITCHGEAR
SYM	SYMMETRICAL

T

T	TREAD
T & B	TOP AND BOTTOM
TEL	TELEPHONE
TEMPO	TEMPORARY
THK	THICK
T.O.	TOP OF
T.O.C.	TOP OF CONCRETE
T.O.S.	TOP OF STEEL
TRANS	TRANSFORMER
TYP	TYPICAL

U

UNO	UNLESS NOTED OTHERWISE
UNINS	UNINSULATED
UR	URINAL

V

VERT	VERTICAL
VEST.	VESTIBULE
V T.R.	VENT THROUGH ROOF

W

W	WIDTH, WEST, WALL
W/	WITH
WC	WATER CLOSET
WD	WOOD
WDW	WINDOW
WG	WASTE GAS
WP	WORK POINT
WT	WEIGHT

LEGEND

- 8 / 999 — SECTION OR DETAIL MARK OR NUMBER — LAST 3 DIGITS OF SHEET NUMBER
- W / 23 — COLUMN MARK W/CENTER LINE
- 123 — ROOM OR AREA MARK NO.
- INTERIOR ELEVATION — 5 / 999 — INT EL NO, SHEET NO, ORIENTATION WHERE NEEDED
- 4 — DOOR MARK NO.
- 8 — WINDOW MARK NO.
- 2 — LOUVER MARK NO.
- RD — ROOF DRAIN
- FD — FLOOR DRAIN

ARCHITECTURAL SYMBOLS

- ACOUSTICAL TILE
- ALUMINUM
- BATT OR LOOSE INSULATION
- BRICK
- CHECKERED A OR METAL GRATING
- CERAMIC MOSAIC TILE
- COLUMN CENTER LINE
- CONCRETE IN ELEVATION OR PLAN
- CONCRETE IN SECTION
- CONCRETE MASONRY UNIT 18" UNO
- INS INT MET. SIDING
- INS INT MET. SIDING W/GYP. BD. IN LIEU OF METAL LINER PANEL & SUBGIRTS
- EARTH (FILLED)
- EARTH (NATURAL)
- FENCE
- GLASS SMALL SCALE
- GLASS - LARGE SCALE
- GYPSUM BOARD - SMALL SCALE
- GYPSUM BOARD - LARGE SCALE
- METAL SIDING (UNINSULATED)
- METAL SIDING (INSULATED)
- PLYWOOD
- PRECAST CONCRETE
- RIGID INSULATION
- ROCK (CRUSHED)
- ROOF INSULATION WITH VAPOR BARRIER
- SAND
- STEEL (LARGE SCALE SECTION)
- VINYL ASBESTOS TILE
- WOOD FINISHED (SECTION)
- WOOD NAILER & BLOCKING
- WOVEN WIRE PARTITION
- STRUCTURAL STEEL

INDEX OF DRAWINGS

DRAWING NUMBERS			REV
516966	A-1	COVER SHEET	
516967	A-2	DRAWING INDEX & SYMBOLS	5
516968	A-3	SITE & ROOF PLANS	
516969	A-4	GROUND FLOOR PLAN	8
516970	A-5	UPPER FLOOR PLAN	9
516971	A-6	EXTERIOR ELEVATION	5
516972	A-7	BUILDING SECTIONS	8
516973	A-8	PRECAST PANEL SCHEDULE	
516974	A-9	PRECAST PANEL SCHEDULE & DETAILS,	
516975	A-10	DOOR SCHEDULE & DETAILS	5
516976	A-11	LOUVER, WINDOW & FINISH SCHEDULES	5
516977	A-12	DETAILS (EXTERIOR)	
516978	A-13	DETAILS (EXTERIOR)	
516979	A-14	DETAILS (EXTERIOR)	
516980	A-15	DETAILS (EXTERIOR)	
516981	A-16	STAIRS	
516982	A-17	REFLECTED CEILING PLANS & INTERIOR ELEVATIONS	
516983	A-18	REFLECTED CEILING PLANS & INTERIOR ELEVATIONS	4
516984	A-19	DETAILS (INTERIOR)	5
516985	A-20	EQUIPMENT LAYOUT	5
521447	A-21	MISCELLANEOUS DETAILS	1
4016831		VALVE CLEAN ROOM & WELDING SHOP EXPANSION KEY PLAN	1
4016832		VALVE CLEAN ROOM SECTIONS, ELEVATIONS & FRAMING PLAN	1
4016833		VALVE CLEAN ROOM DETAILS	1
4016834		WELDING SHOP EXPANSION DETAILS	1
4013077		ACCESS PLATFORM TO MAIN BRIDGE CRANE	1
4015454		ACCESS PLATFORM TO ELECT. SHOP BRIDGE CRANE	1
516992	C-1	FINISH GRADING PLAN	
516993	C-2	YARD FACILITIES & DETAILS	
516994	C-3	FOUNDATION PLANS & DETAILS	
516995	C-4	FOUNDATION & MEZZANINE FLOOR DETAILS	
516996	C-5	ROOF & FLOOR FRAMING PLANS	
516997	C-6	STRUCTURAL STEEL, SECTIONS & DETAILS	
516998	C-7	MISCELLANEOUS STEEL DETAILS	
516999	C-8	PRECAST PANEL SUPPORT SYSTEM & DETAILS	
517000	C-9	PRECAST PANEL DETAILS	
521464	C-10	PLANS, SECTIONS & DETAILS	1
521465	C-11	MISCELLANEOUS DETAILS	1
SK 514660		SEWAGE SYSTEM - POWER PLANT AREA OVERALL PLAN	
SK 514665		SEWAGE SYSTEM - PUMP PITS - SECTIONS & DETAILS	
SK 515964		DOMESTIC & POTABLE WATER SYSTEM PIPING LAYOUT - PLANT AREA	

INDEX OF DRAWINGS

DRAWING NUMBERS			REV
517008	M-1	HVAC LEGENDS, P&ID & SCHEDULES.	
517009	M-2	HVAC GROUND FLOOR PLAN	5
517010	M-3	HVAC UPPER FLOOR PLAN	8
517011	M-4	HVAC SECTIONS	7
517012	M-5	PLUMBING, FIRE PROTECTION & DRAINAGE, GROUND FLOOR	5
517013	M-6	PLUMBING, FIRE PROTECTION & DRAINAGE, UPPER FLOOR	4
517014	M-7	PLUMBING, FIRE PROTECTION DETAILS	
517015	M-8	COMPRESSED AIR LAYOUT	
517021	E-1	GENERAL NOTES, SINGLE LINE DIAGRAM	
517022	E-2	POWER PANEL SCHEDULES 'PP1-PP4'	7
517023	E-3	LIGHTING PANEL SCHEDULES 'LP1'-'LP6'	8
517024	E-4	CONDUIT LAYOUT GROUND FLOOR	9
517025	E-5	CONDUIT LAYOUT UPPER FLOOR	8
517026	E-6	LIGHTING, COMMUNICATION & RECEPTACLE LAYOUT GROUND FLOOR	9
517027	E-7	LIGHTING, COMMUNICATION & RECEPTACLE LAYOUT UPPER FLOOR	7
517028	E-8	GROUNDING — GROUND FLOOR PLAN	
517029	E-9	HVAC & MISCELLANEOUS SCHEMATIC DIAGRAMS	
517030	E-10	CIRCUIT SCHEDULE	
517031	E-11	RACEWAY SCHEDULE	

GENERAL NOTES

1.) SEE STRUCTURAL DRAWINGS FOR THE FOLLOWING:
- A.) CHECKERED PLATE AND METAL GRATING LAYOUT AND DETAILS.
- B.) COLUMN, BEAM OR GIRT LOCATIONS AND/OR SIZES.
- C.) THICKNESS AND LOCATION OF CONC. WALLS.
- D.) CONCRETE SLAB LAYOUT

2.) FOR FLOOR DRAIN LOCATIONS AND SIZE IN UNFINISHED AREAS, SEE MECHANICAL OR CIVIL DRAWINGS

3.) MECHANICAL EQUIPMENT LAYOUT NOT SHOWN FOR CLARITY SEE MECHANICAL DRAWINGS

4.) DISSIMILAR METALS OTHER THAN STAINLESS STEEL WHICH COME IN CONTACT WITH ALUMINUM SURFACES SHALL BE PAINTED WITH A PRIME COAT OF ZINC CHROMATE PRIMER AND TWO COATS OF ALUMINUM PAINT; OR ONE HEAVY BRUSH COAT OF ALKALI-RESISTANT BITUMINOUS PAINT, OR COATED WITH A HEAVY COAT OF CALKING COMPOUND, OR SEPARATED BY A NON-ABSORPTIVE TAPE OR GASKET.

5.) C.M.U. THICKNESSES SHOWN ARE NOMINAL.

6.) FOR CONVERSION OF ROOM 201 FROM STORAGE TO OFFICE AREA SEE DRAWINGS:
- 495142-A-1 - PLAN, INTERIOR ELEVATIONS, DETAILS - REV. 1
- 495143-M-1 - PLANS, SCHEDULES, NOTES, SECTION - REV. 1
- 495144-E-1 - SINGLE LINE DIAGRAM, SCHEDULES, NOTES - REV. 1
- 495145-E-2 - LIGHTING & POWER, PLANS & DETAILS - REV. 1
- 498682 - PLUMBING & SPRINKLER MODIFICATIONS - REV. 1

REV				
4	GEORGE VILLAREAL	George Villareal	C-8972	2-28-93
3	GEORGE VILLAREAL	Jorge Villareal	C-8972	2-28-91
REV	REGISTERED ARCHITECT	SIGNATURE	CA. REG. NO.	EXP. DATE

A-2

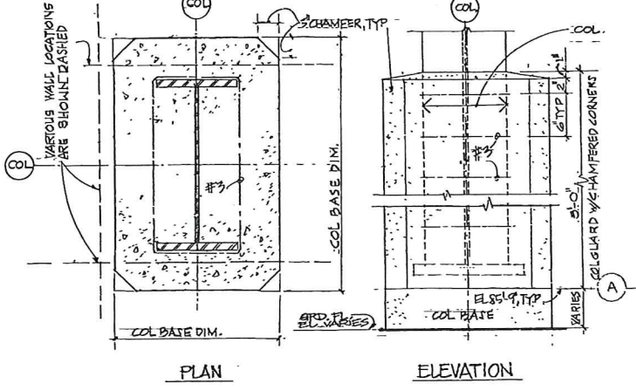
REV. 5 & ON SEE DWG. 063618 FOR APPROVER'S STAMP.

JIM INDEXED REV. 4

James M Leafe C1718 CALIF. REG. ARCHT.

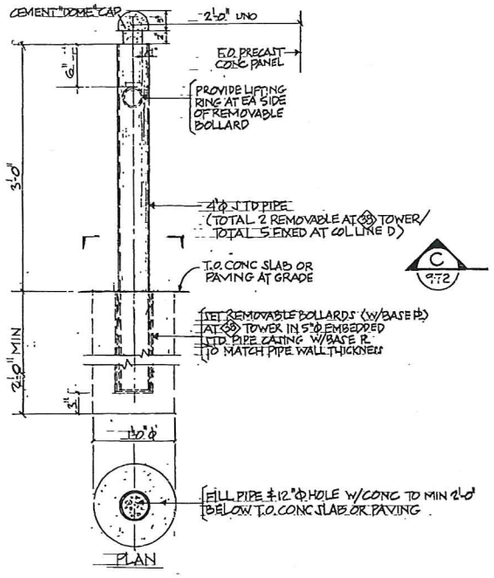
UNIT 2 COAST VALLEYS DIVISION MICROFILM

4 12 91 MODIFIED PER PCO-EA-41145-R0 BJ: 244 KH WSR WR2 11/25 ZDS ACCEPTED



1/1 TYP. STEEL & CONC. COLUMN GUARD DETAILS

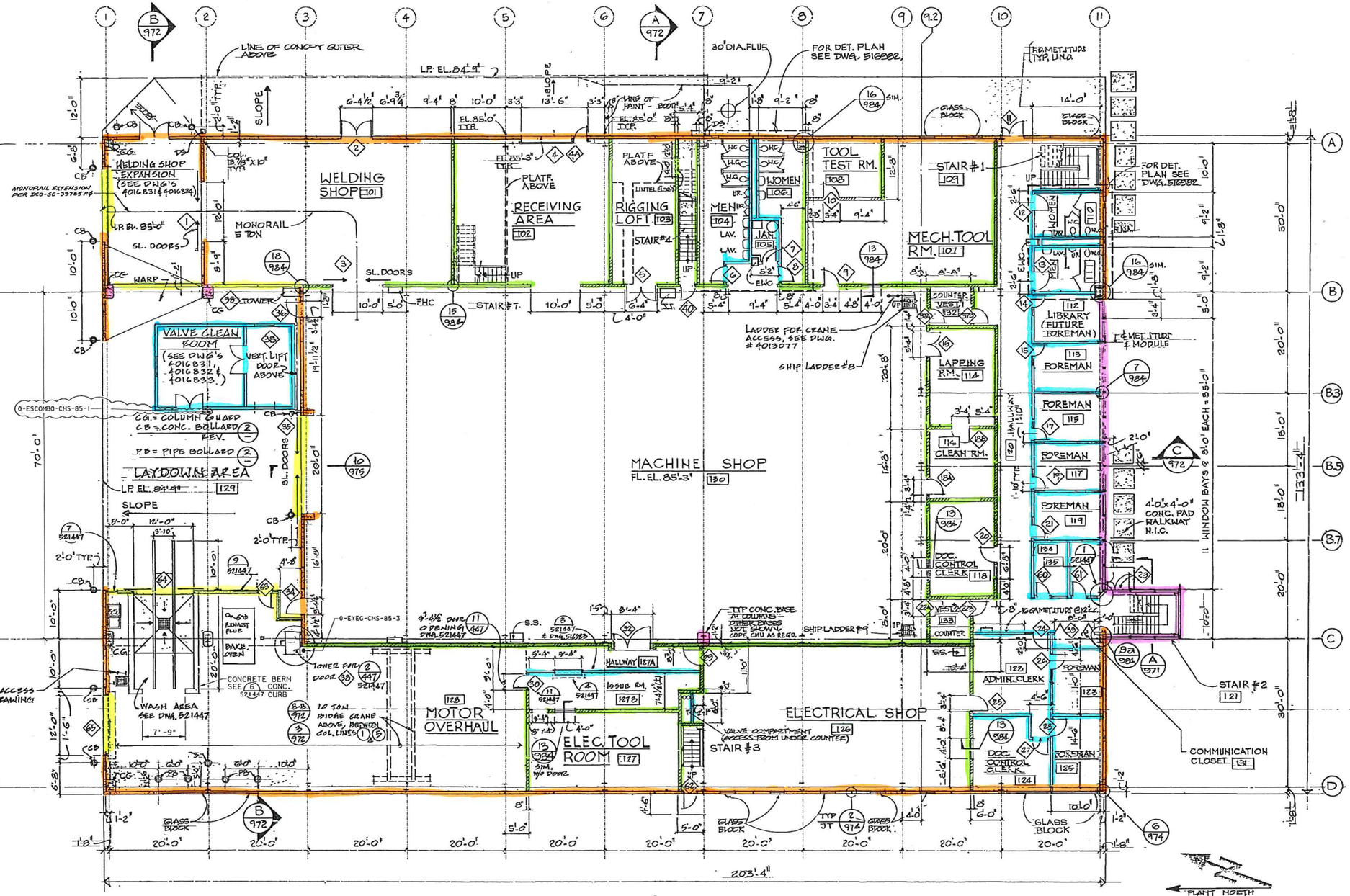
1 1/2" = 1'-0" (TOTAL 6 AT LAYDOWN AREA)



2/1 SECTION AT PIPE BOLLARD

1 1/2" = 1'-0"

TOTAL 21 AT LAYDOWN AREA:
- 14 CONC. BOLLARDS PER REV. 4
- 5 FIXED PIPE BOLLARDS AS SHOWN
- 2 REMOVABLE PIPE BOLLARDS AS SHOWN

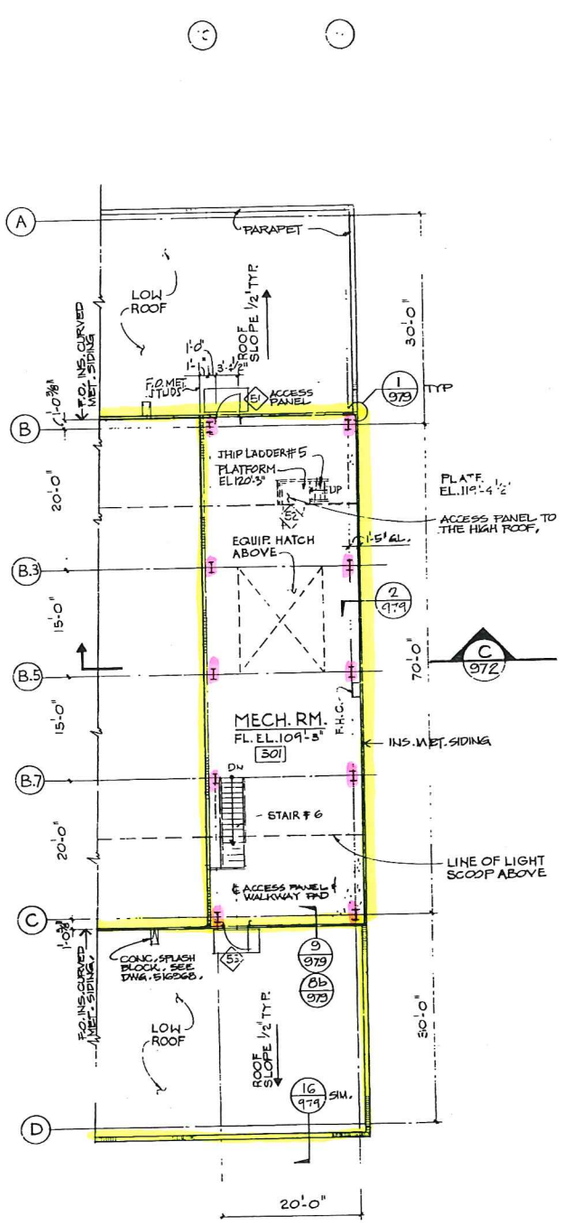


GROUND FLOOR PLAN EL. 85'-3"

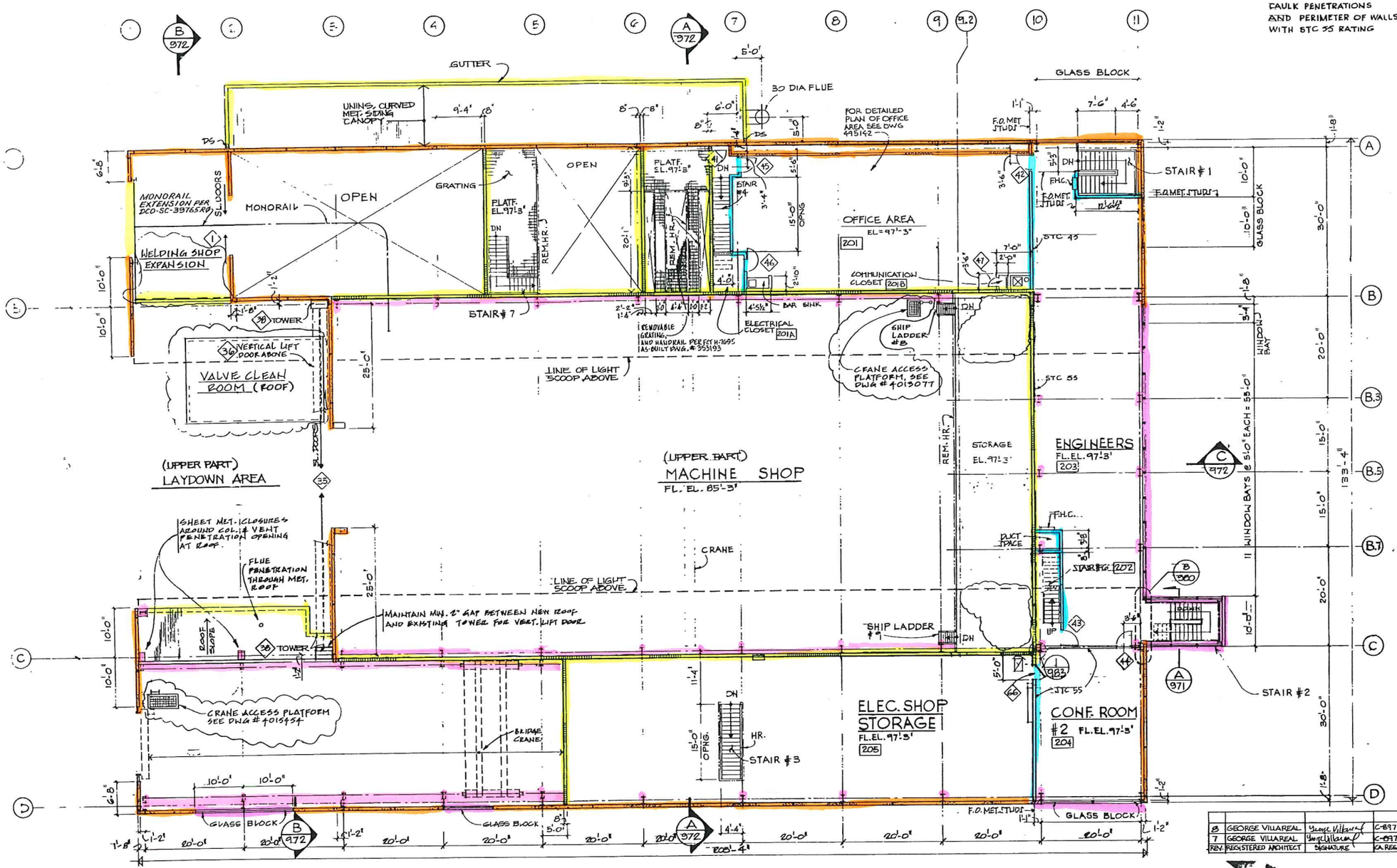
1/8" = 1'-0"

CONC. SPLASH BLOCKS ALONG COL. LINE Ⓓ NOT SHOWN, SEE ROOF PLAN DWG. 516968

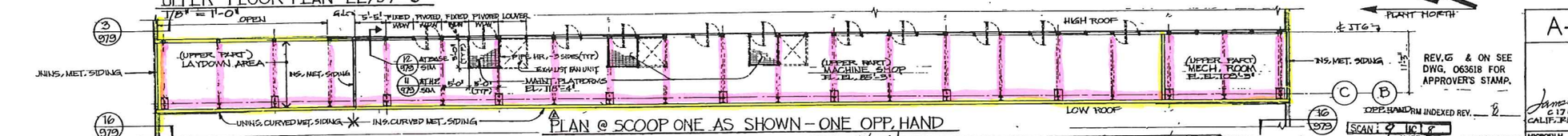
SOUND INSULATION:
CAULK PENETRATIONS
AND PERIMETER OF WALLS
WITH STC 55 RATING



MECH. ROOM EL. 109'-3"
18"=1'-0"



UPPER FLOOR PLAN EL. 97'-3"
1/8" = 1'-0"



PLAN @ SCOOP ONE AS SHOWN - ONE OPP. HAND

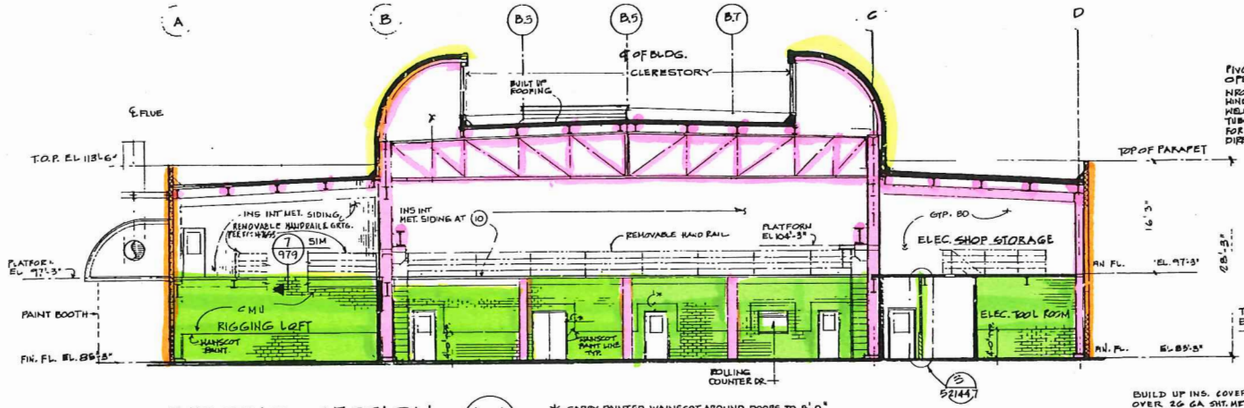
REV.	REGISTERED ARCHITECT	SIGNATURE	
8	GEORGE VILLAREAL	George Villareal	C-8972
7	GEORGE VILLAREAL	George Villareal	C-8972

REV. G & ON SEE DWG. 063618 FOR APPROVER'S STAMP.

OPP. HAND RM INDEXED REV. G

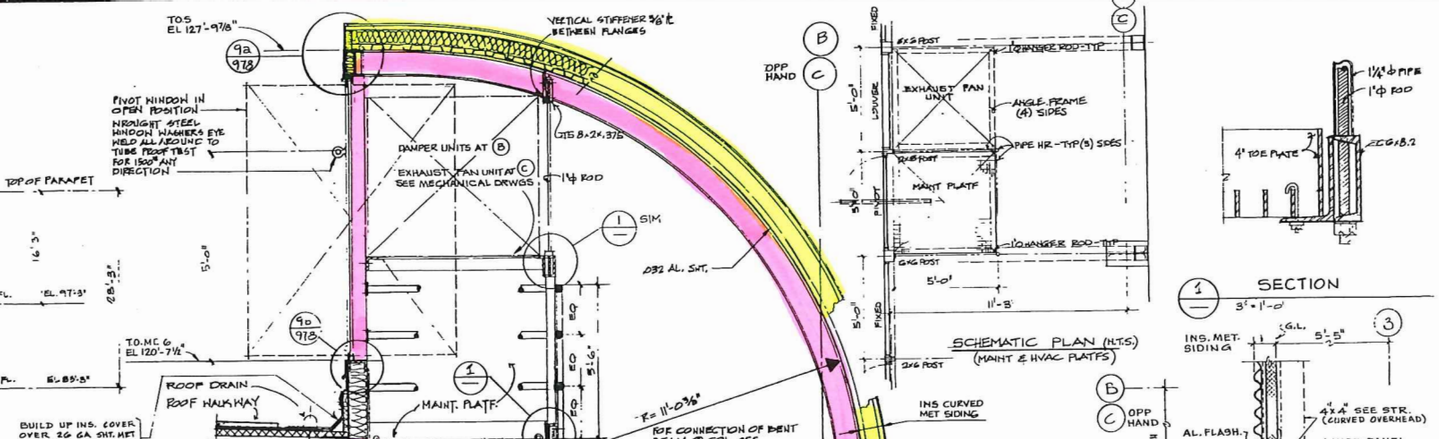
SCAN: 9 10 8

A-



BUILDING SECTION A-A
⅛"=1'-0"

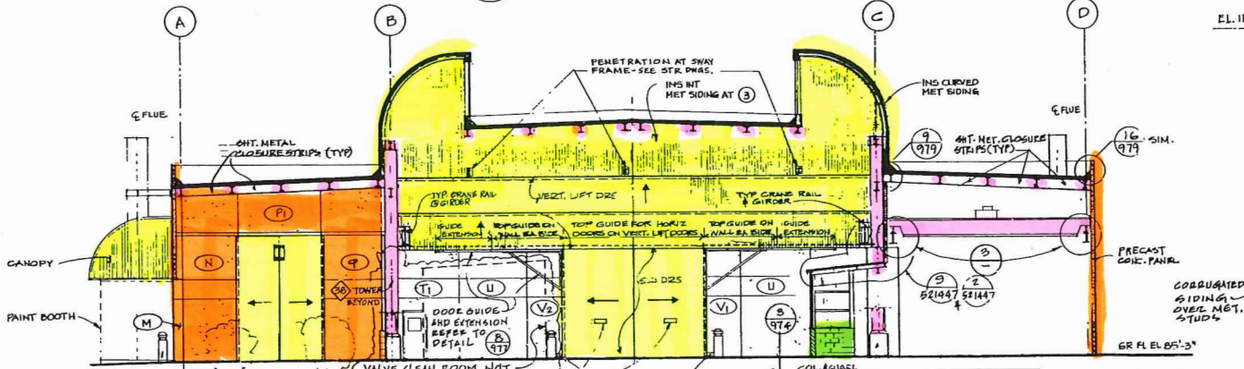
* CARRY PAINTED WAINSCOT AROUND DOORS TO 8'-0" HIGH C.M.U. JT AT HEAD & SYMMETRICALLY AT EACH JAMB ABOVE 4'-0" HIGH TYP. PAINTED C.M.U. WAINSCOT



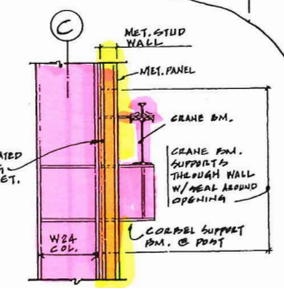
A TYP. SECTION @ SCOOP
⅜"=1'-0"

1 SECTION
3"=1'-0"

2 PLAN AT SCOOP
1½"=1'-0"



BUILDING SECTION B-B
⅛"=1'-0"

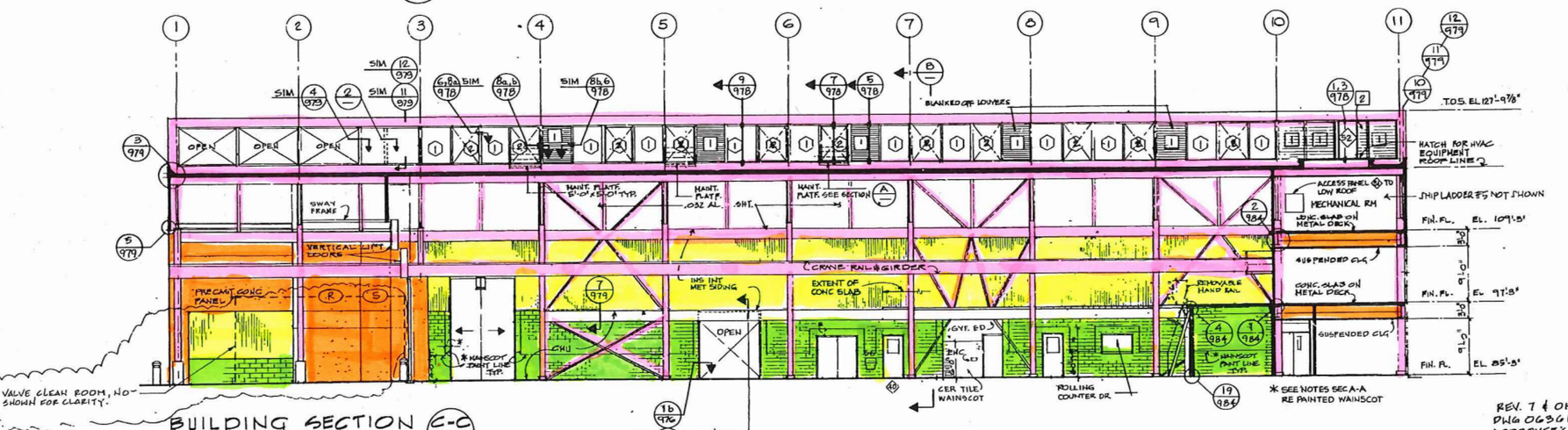


3 CRANE BM. SUPPORT
½"=1'-0"

DO NOT OPEN OVERHEAD DOORS UNLESS SLIDING DOORS ARE OPEN

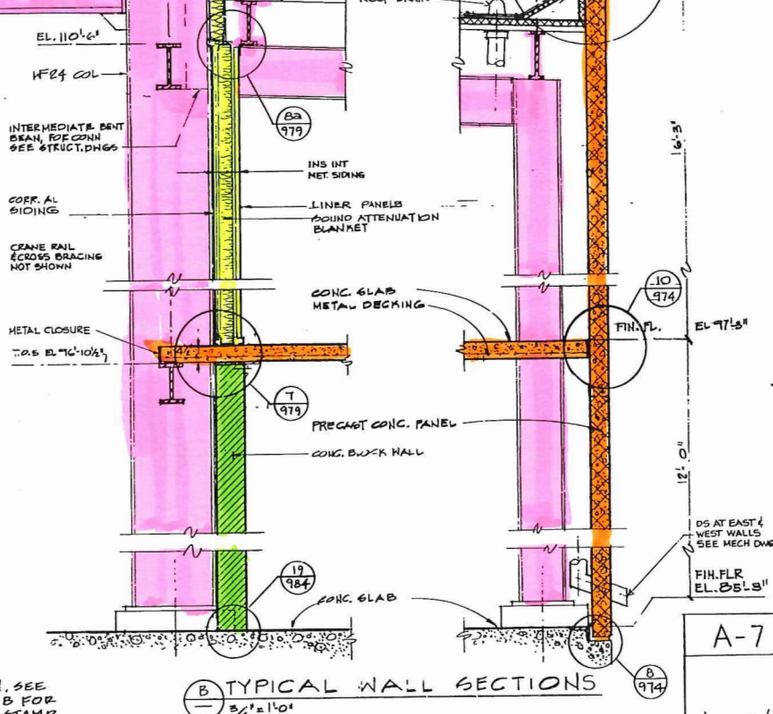
NEW SAFETY SIGN INSTALL NEXT TO OVERHEAD DOOR OPERATING CONTROL

LAMACOID SIGN



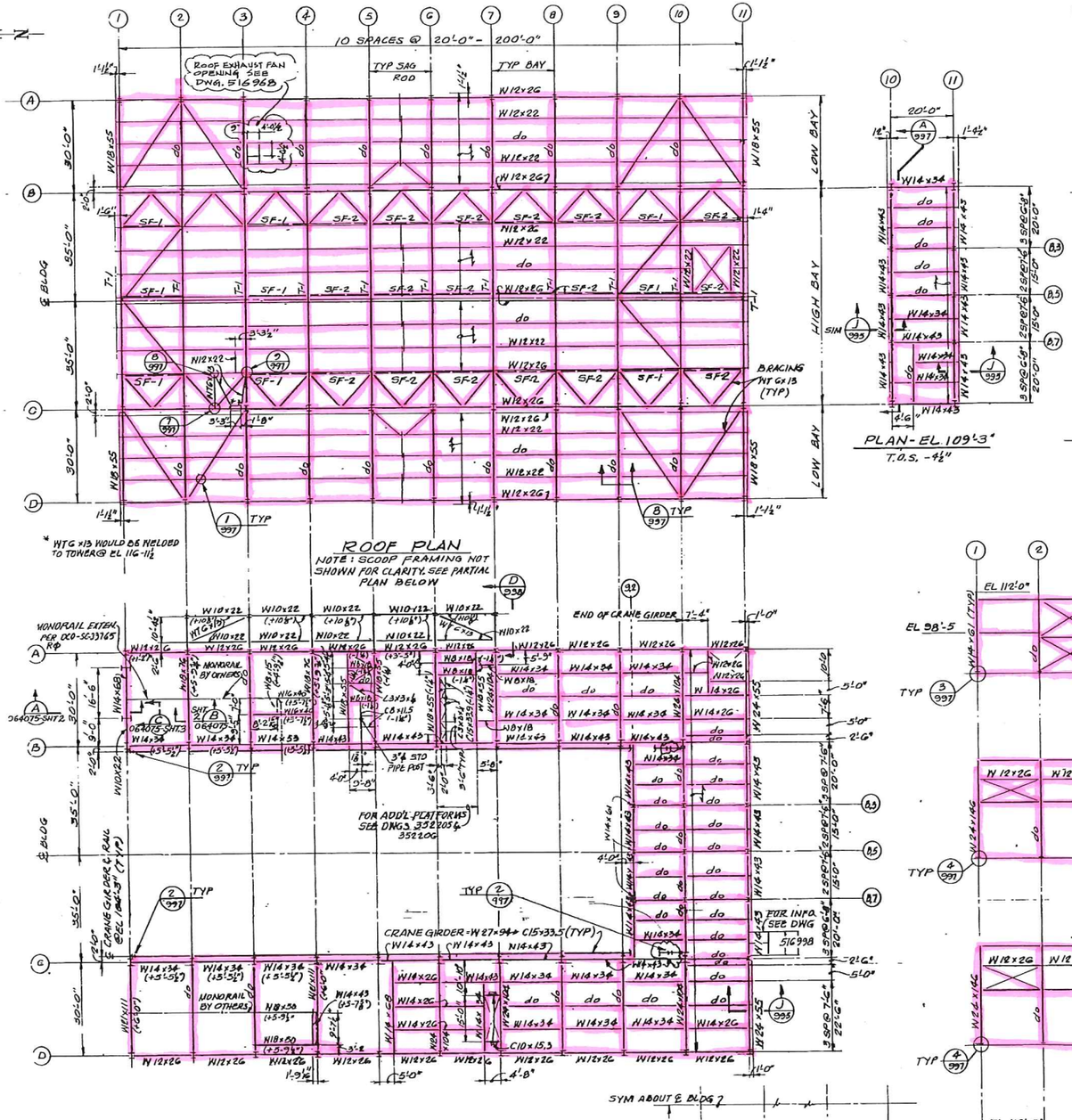
BUILDING SECTION C-C
⅛"=1'-0"

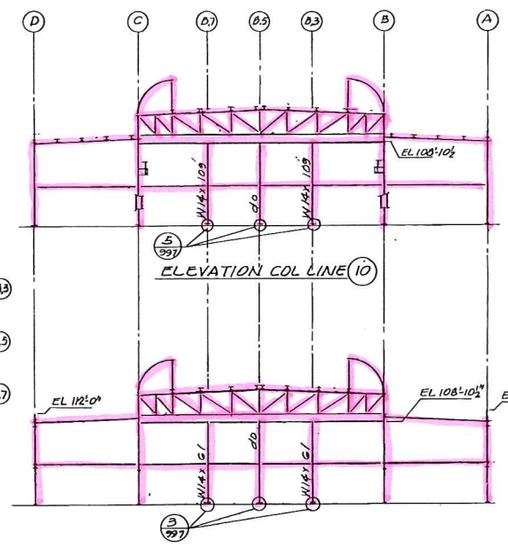
REV. 7 & ON. SEE DWG 06361B FOR APPROVER'S STAMP

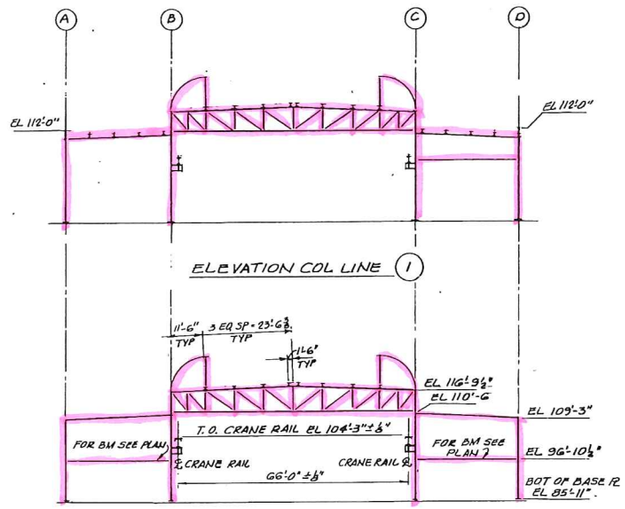


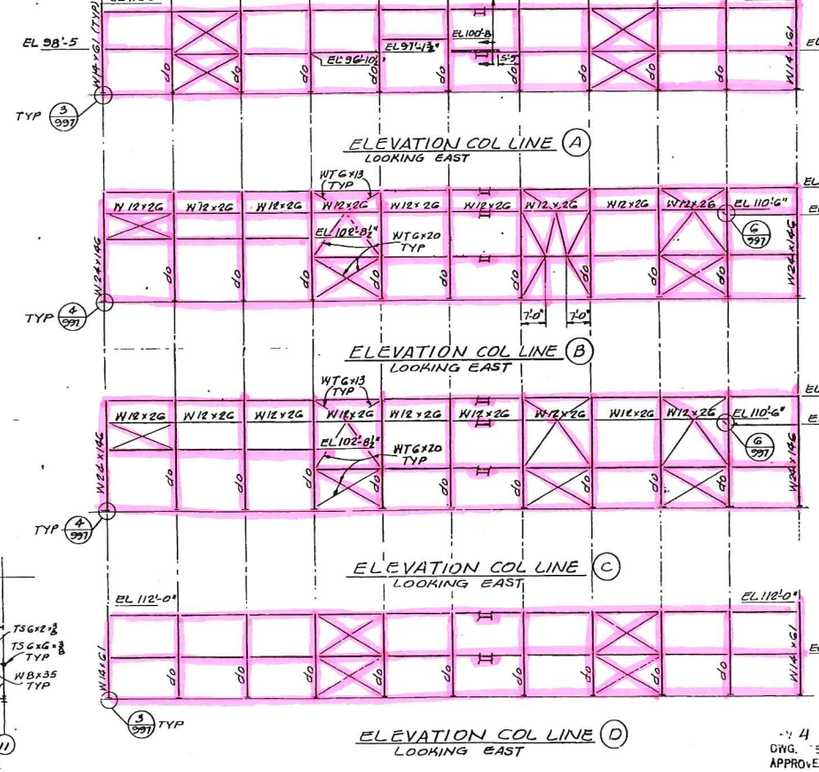
B TYPICAL WALL SECTIONS
3/4"=1'-0"

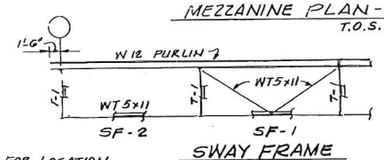
A-7

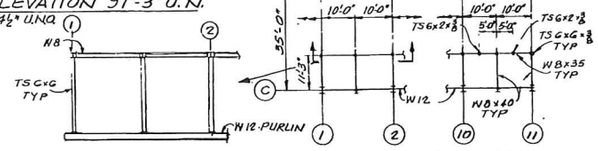












NOTES:

1.- FURNISHING, FABRICATION AND ERECTION OF ALL STRUCTURAL STEEL IS IN ACCORDANCE WITH SPECIFICATION 7GB2.

2.- FABRICATION WAS PERFORMED IN ACCORDANCE WITH THE SHOP DRAWINGS APPROVED BY THE ENGINEER

3.- ANY DEVIATIONS FROM THE DESIGN DRAWINGS WERE APPROVED BY THE ENGINEER.

4.- MATERIALS CONFORM TO THE FOLLOWING:
STRUCTURAL SHAPES, PLATES AND ANCHOR BOLTS ASTM A-36
STRUCTURAL TUBING ASTM A-501

5.- A) ALL BOLTS SHALL BE HIGH STRENGTH BOLTS CONFORMING TO ASTM A-325 BEARING TYPE UNLESS NOTED OTHERWISE.

B) UNLESS NOTED OTHERWISE, BOLTS SHALL BE ¾" ϕ

C) BEAM TO BEAM AND BEAM TO COLUMN CONNECTION WAS PROVIDED IN ACCORDANCE WITH AISC TABLE II WITH MAXIMUM NUMBER OF BOLT ROWS

6.- A) ALL WELDING IS PERFORMED IN ACCORDANCE WITH STRUCTURAL WELDING CODE AWS D1.1

B) WHEN FILLET WELDS ARE CALLED OUT WITHOUT SIZE, MINIMUM FILLET SIZE IN ACCORDANCE WITH THE AISC SPECIFICATION SHALL BE PROVIDED.

7.- FOR BRACING MEMBERS, THE CONNECTION SHALL BE DESIGNED FOR THE REACTIONS:

A) ROOF BRACING = ± 25 KIPS

B) VERTICAL BRACING ON COL. LINES A, B, C & D = ± 30 KIPS EXCEPT AS NOTED BELOW

C) VERTICAL BRACING ON LINES B & C BELOW EL 97'-3" = ± 35 KIPS

8.- ALL STRUCTURAL STEEL SHALL BE PAINTED IN ACCORDANCE WITH SPECIFICATION 7GB2.

9.- ALL FULL PENETRATION WELDS SHALL BE EXAMINED BY ULTRASONIC TESTING (UT).

10.- FOR ADDITIONAL NOTES AND REFERENCE DRAWINGS SEE DWG. 516997

REFERENCE DRAWINGS

COLD MACHINE SHOP	FINISH GRADING PLAN	516992
	YARD FACILITIES AND DETAILS	516993
	FOUNDATION PLAN	516994
	FOUNDATIONS AND SECTIONS	516995
	STRUCTURAL STEEL SECT & DET'S	516997
	MISCELLANEOUS STEEL DETAILS	516998
COLD MACHINE SHOP	PRECAST PANEL SUPPORT SYSTEM & DET	516999

C-5

Appendix L: Pathfinder Simulation

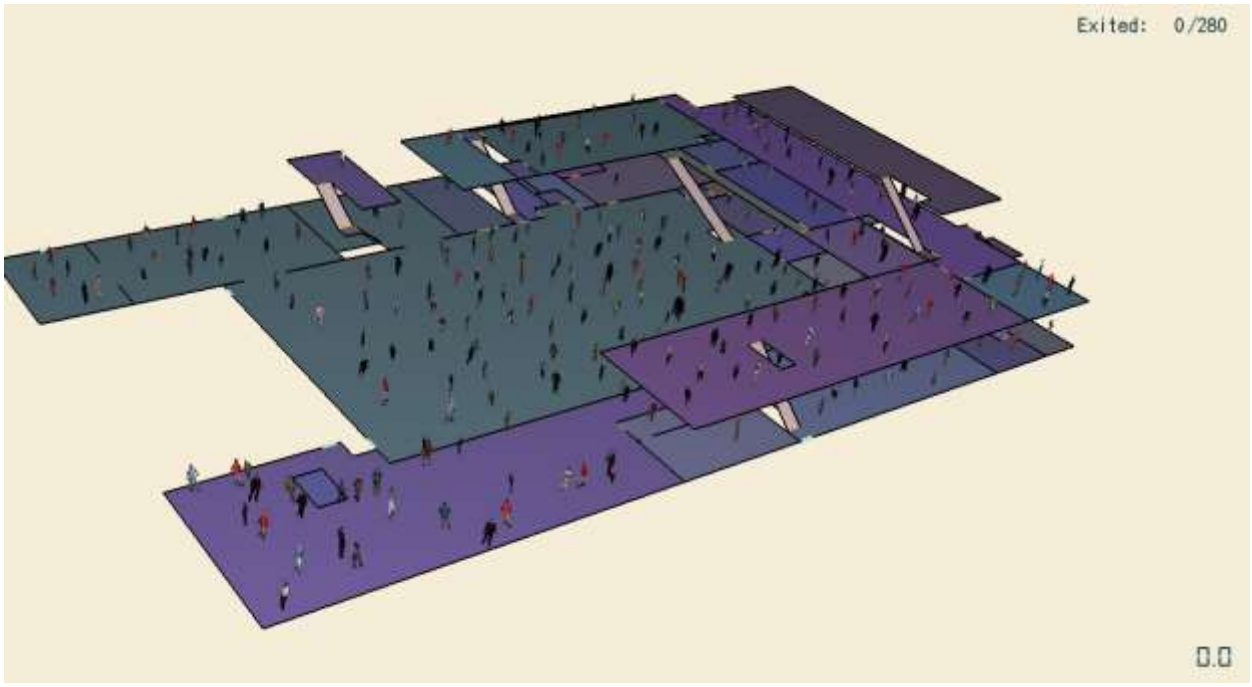


Figure 63: Simulation View @ 0s from NW Corner

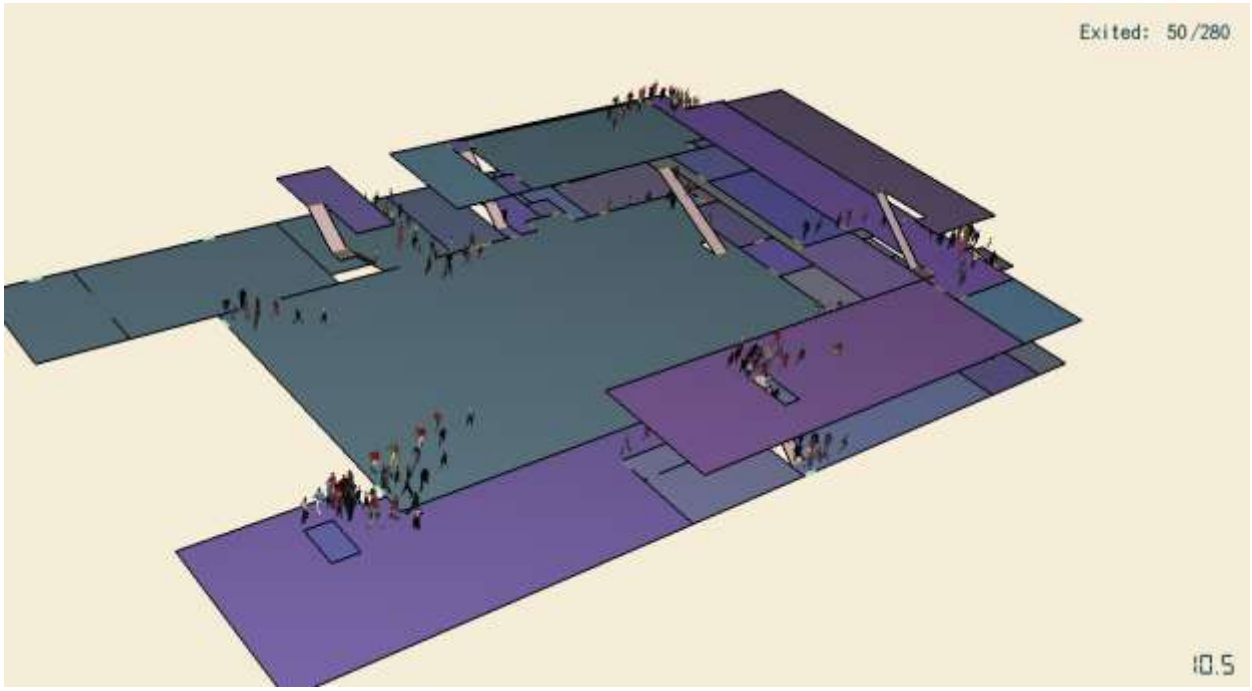


Figure 64: Simulation View @ 10s from NW Corner

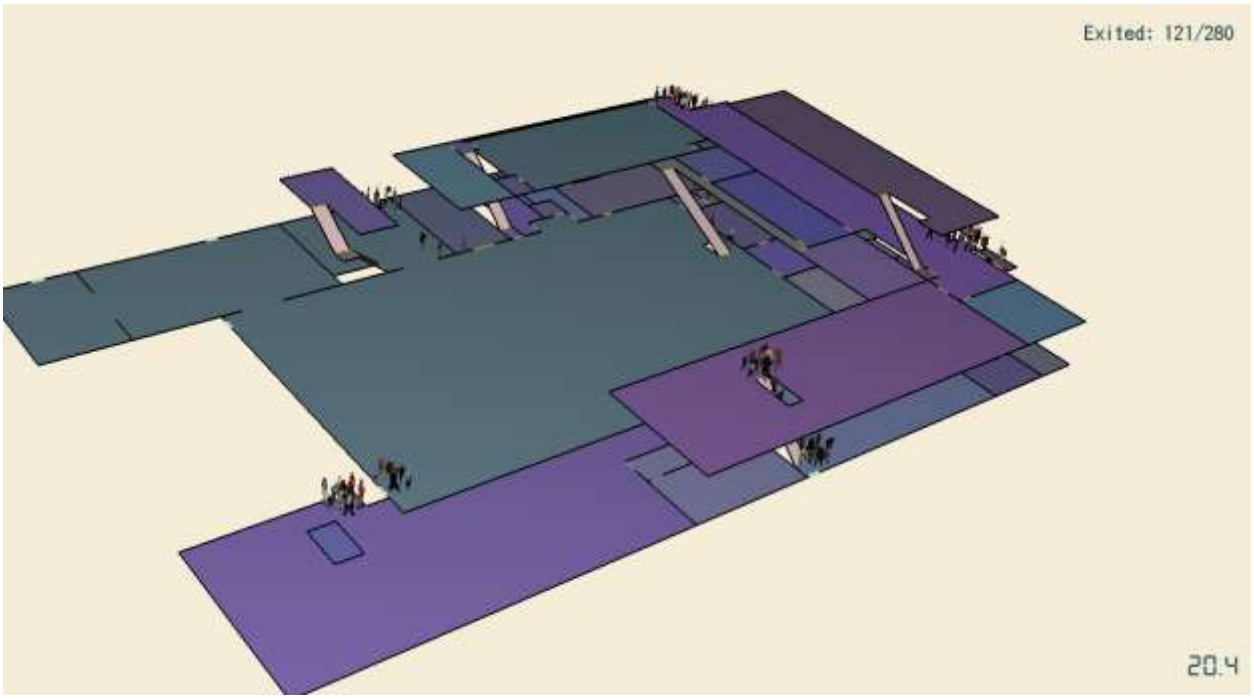


Figure 65: Simulation View @ 20s from NW Corner

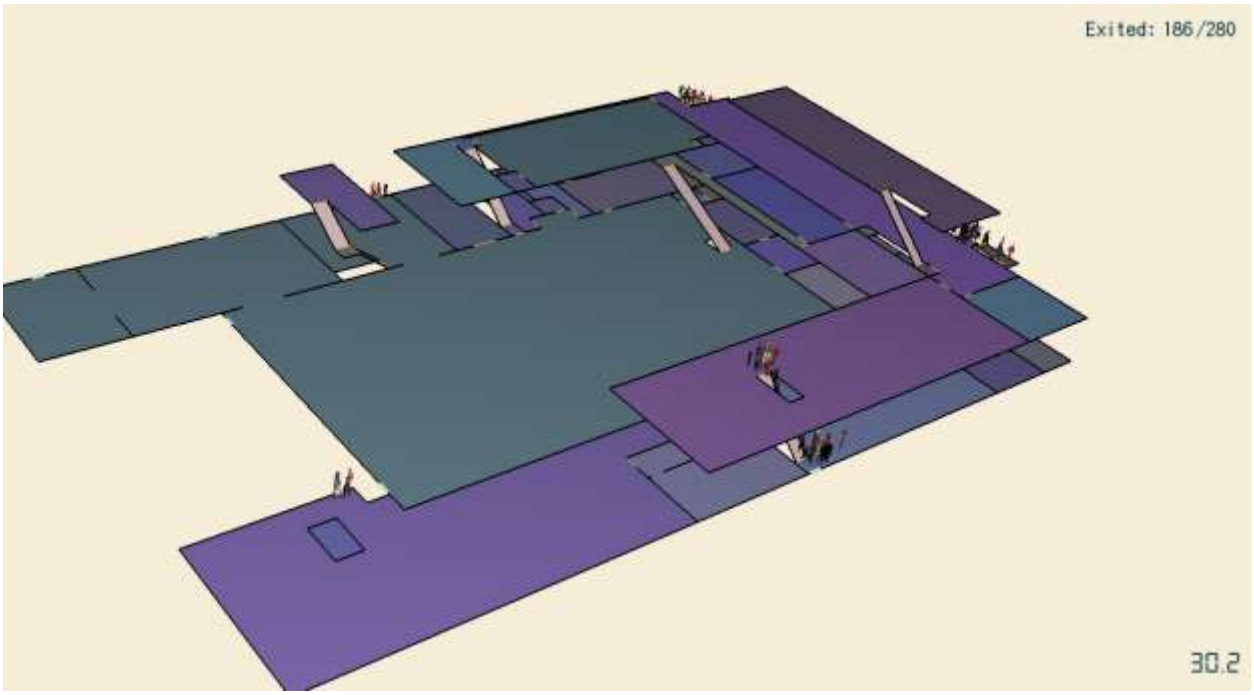


Figure 66: Simulation View @ 30s from NW Corner

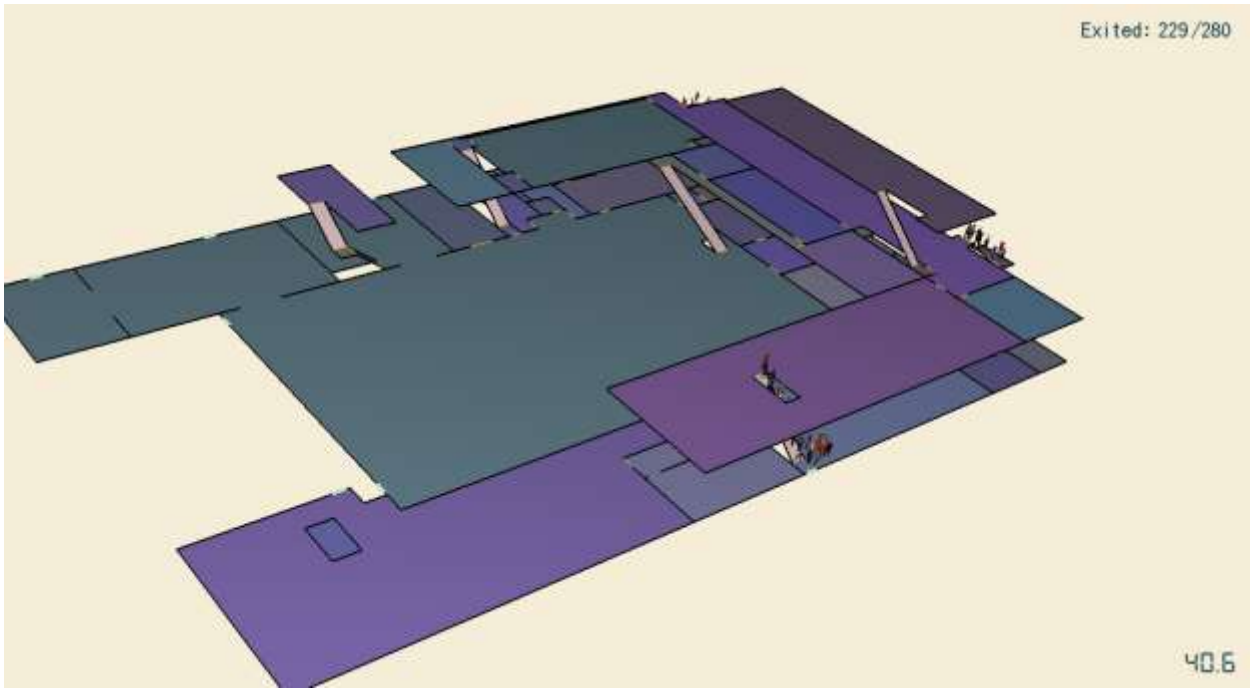


Figure 67: Simulation View @ 40s from NW Corner

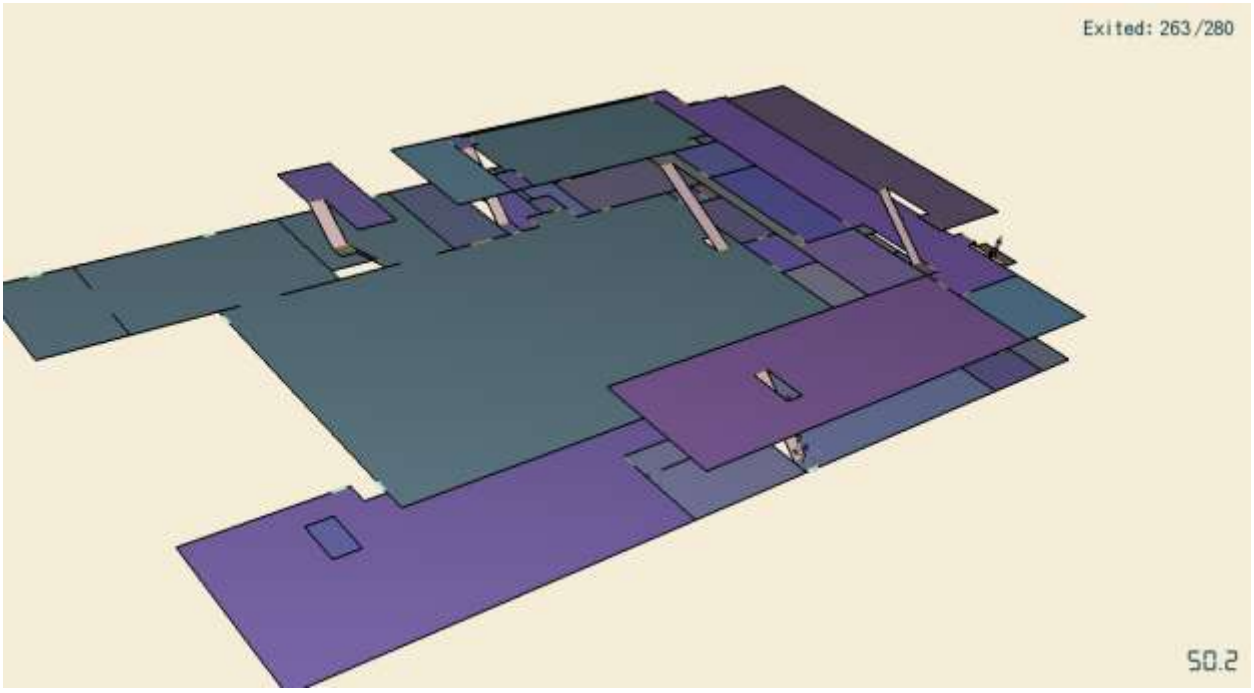


Figure 68: Simulation View @ 50s from NW Corner

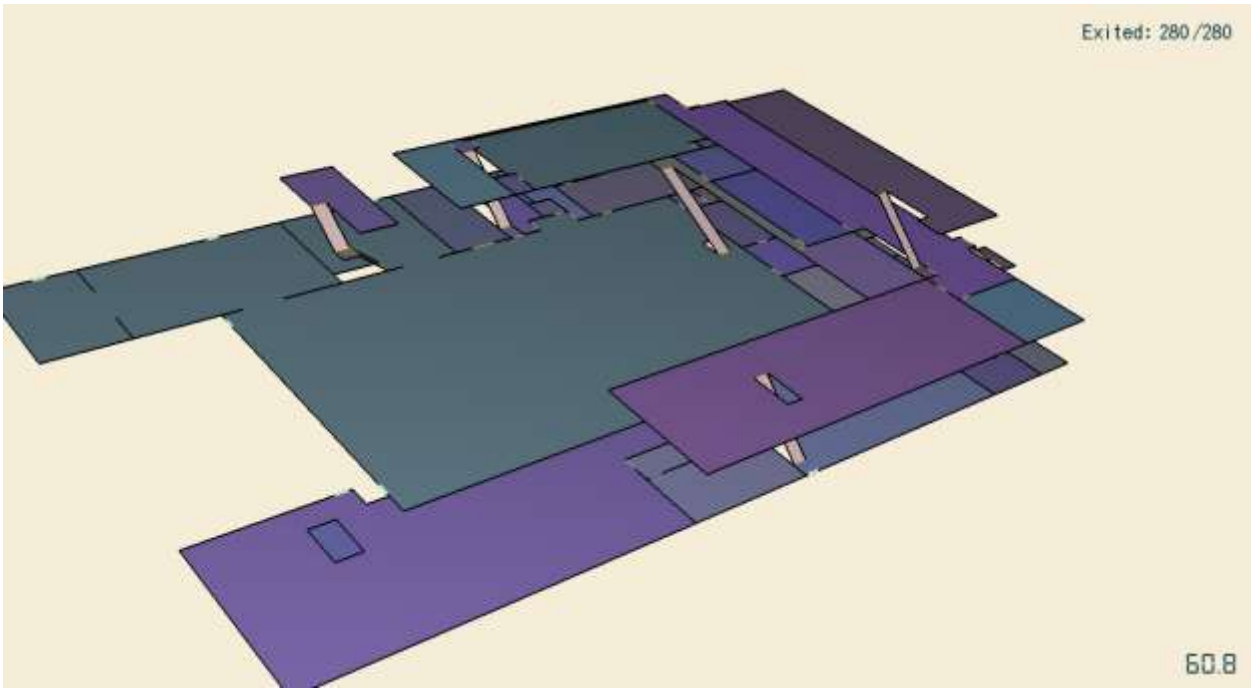


Figure 69: Simulation View @ 60s from NW Corner

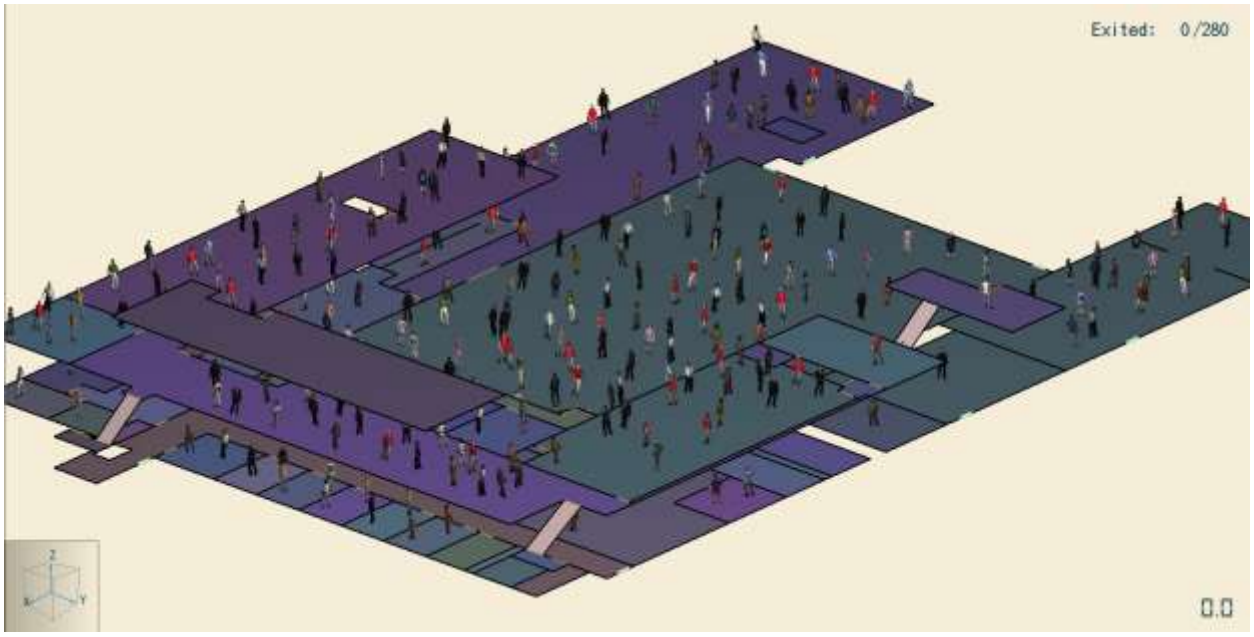


Figure 70: Simulation View @ 0s from SE Corner

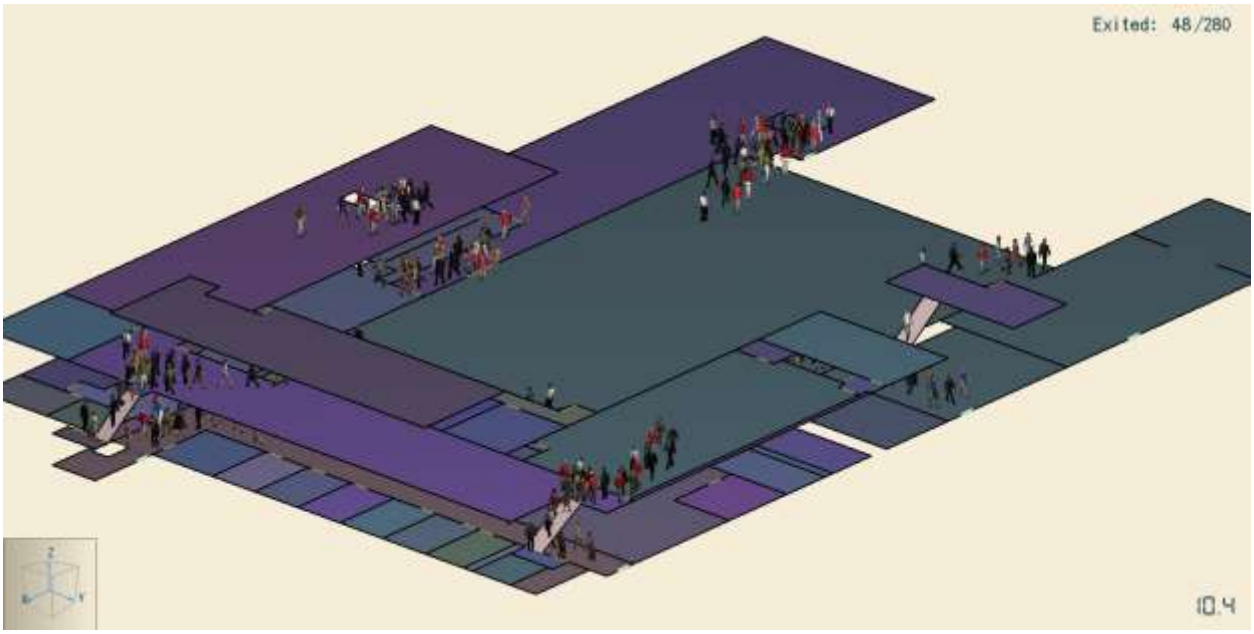


Figure 71: Simulation View @ 10s from SE Corner

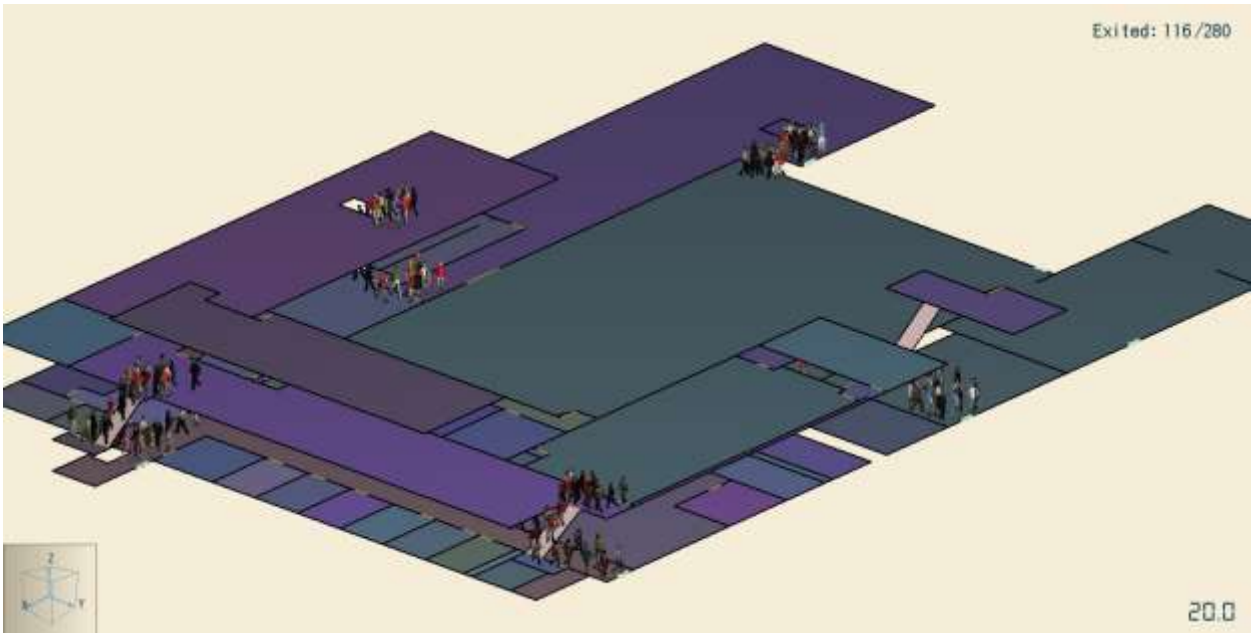


Figure 72: Simulation View @ 20s from SE Corner

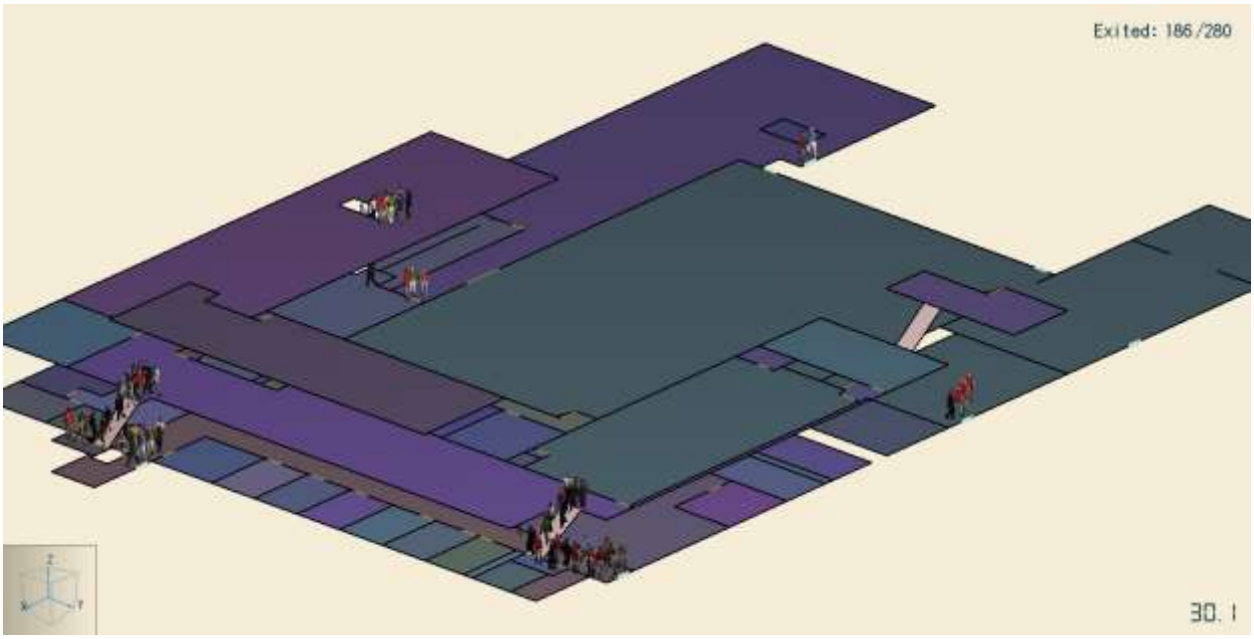


Figure 73: Simulation View @ 30s from SE Corner

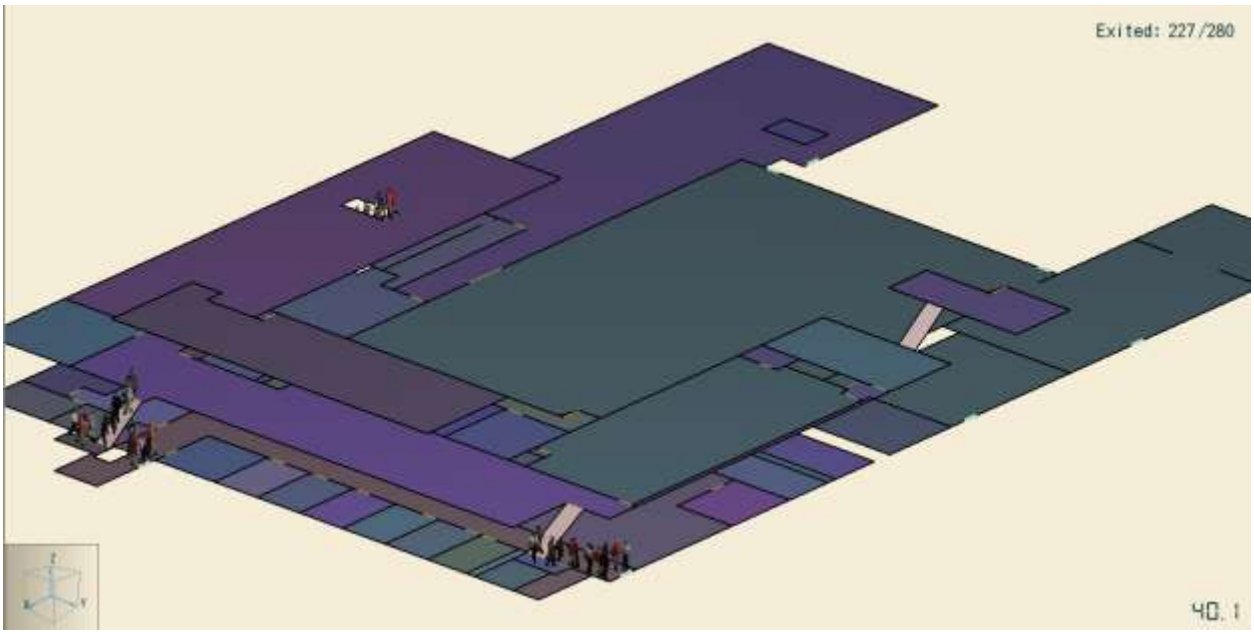


Figure 74: Simulation View @ 40s from SE Corner

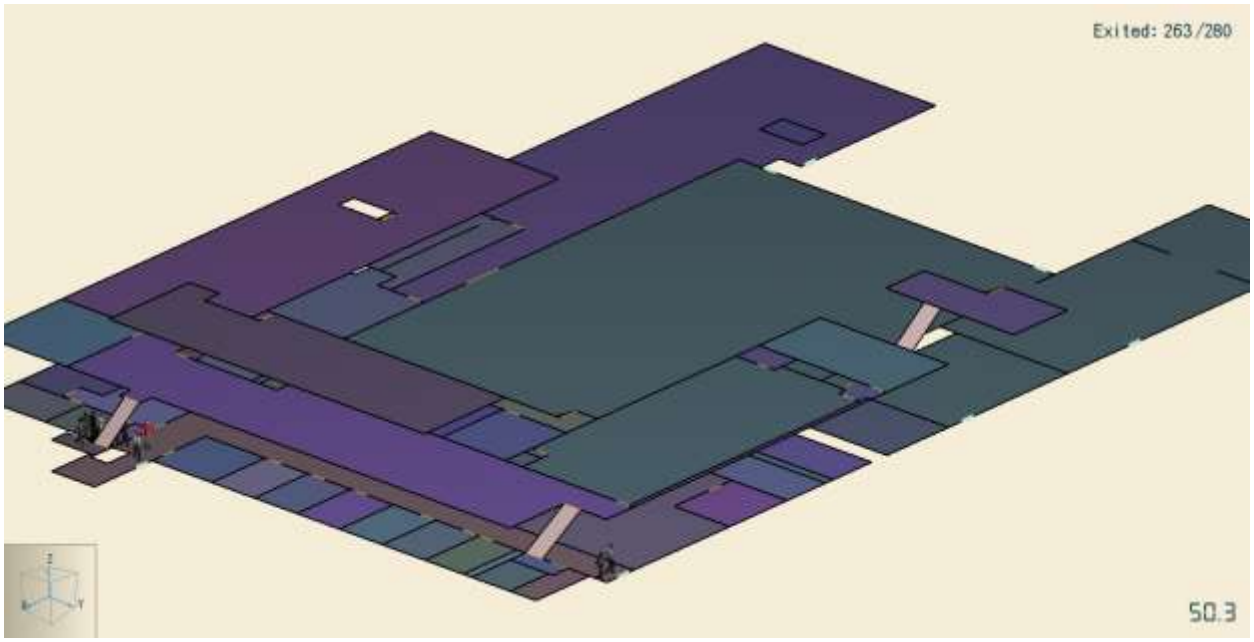


Figure 75: Simulation View @ 50s from SE Corner

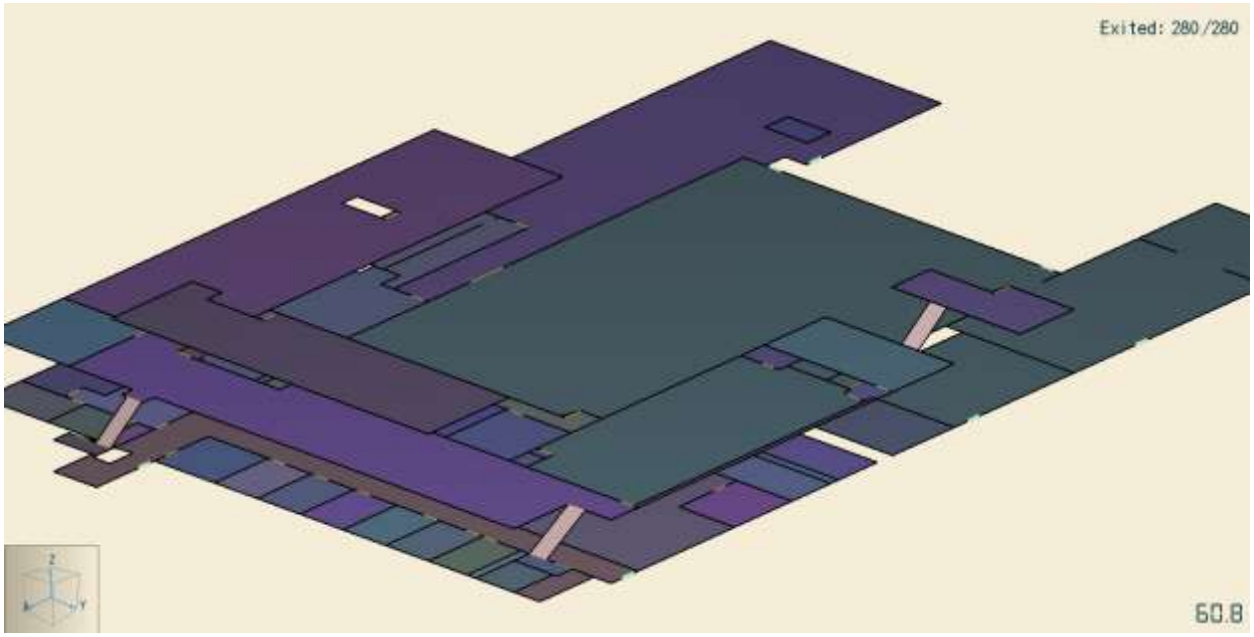


Figure 76: Simulation View @ 60s from SE Corner

Appendix M: Pallet Fire Simulation

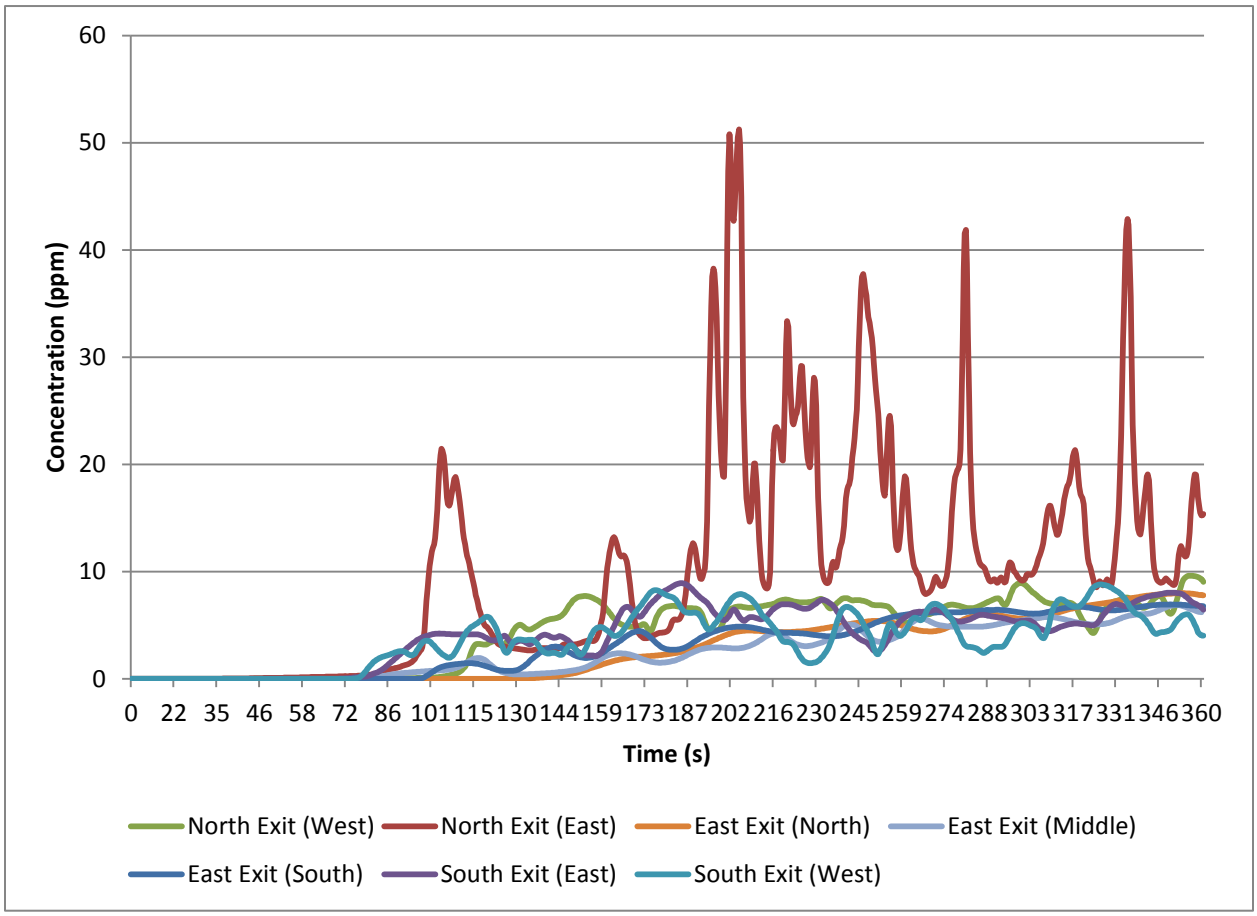


Figure 77: Pallet Fire CO Concentration vs. Time Plot

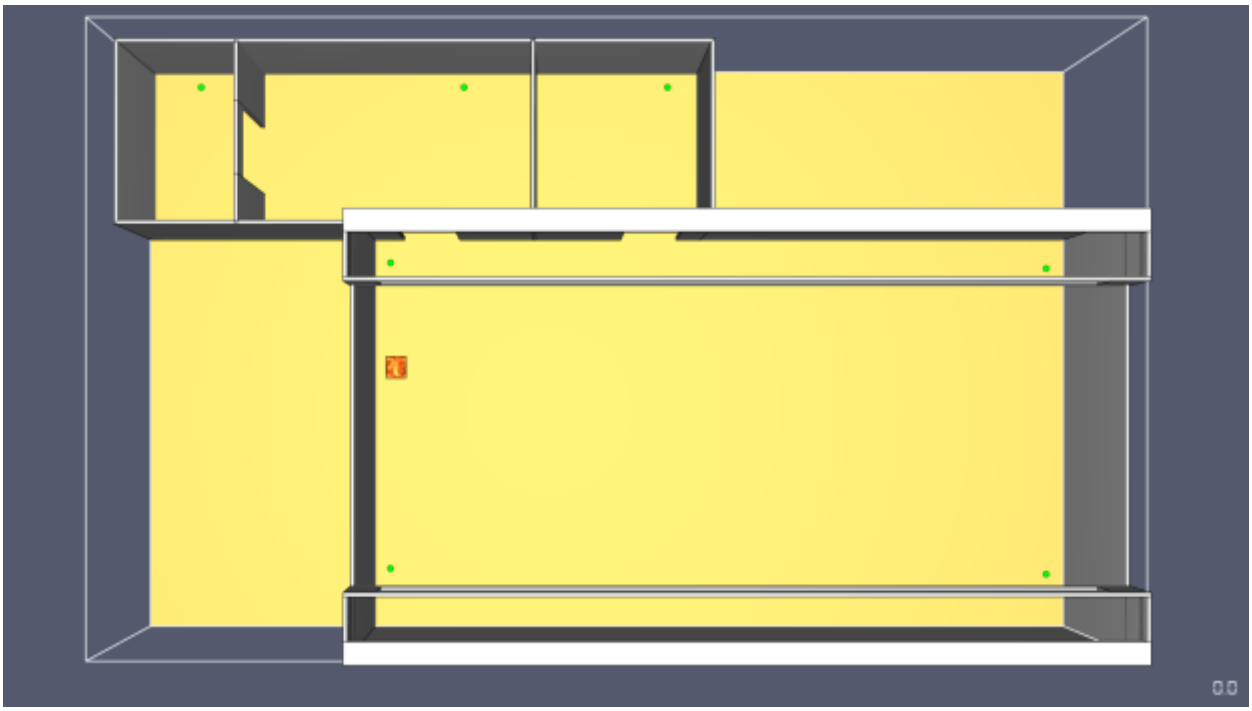


Figure 78: Pallet Fire SmokeView @ 0s - Top View

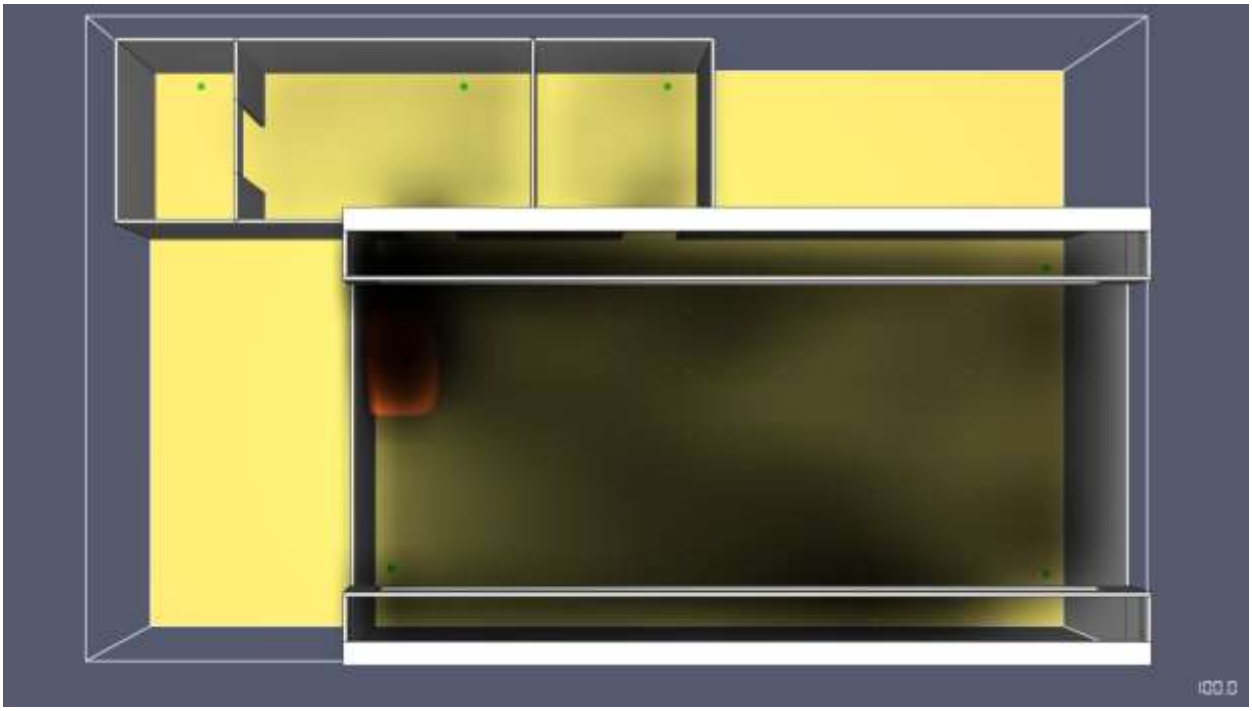


Figure 79: Pallet Fire SmokeView @ 100s - Top View

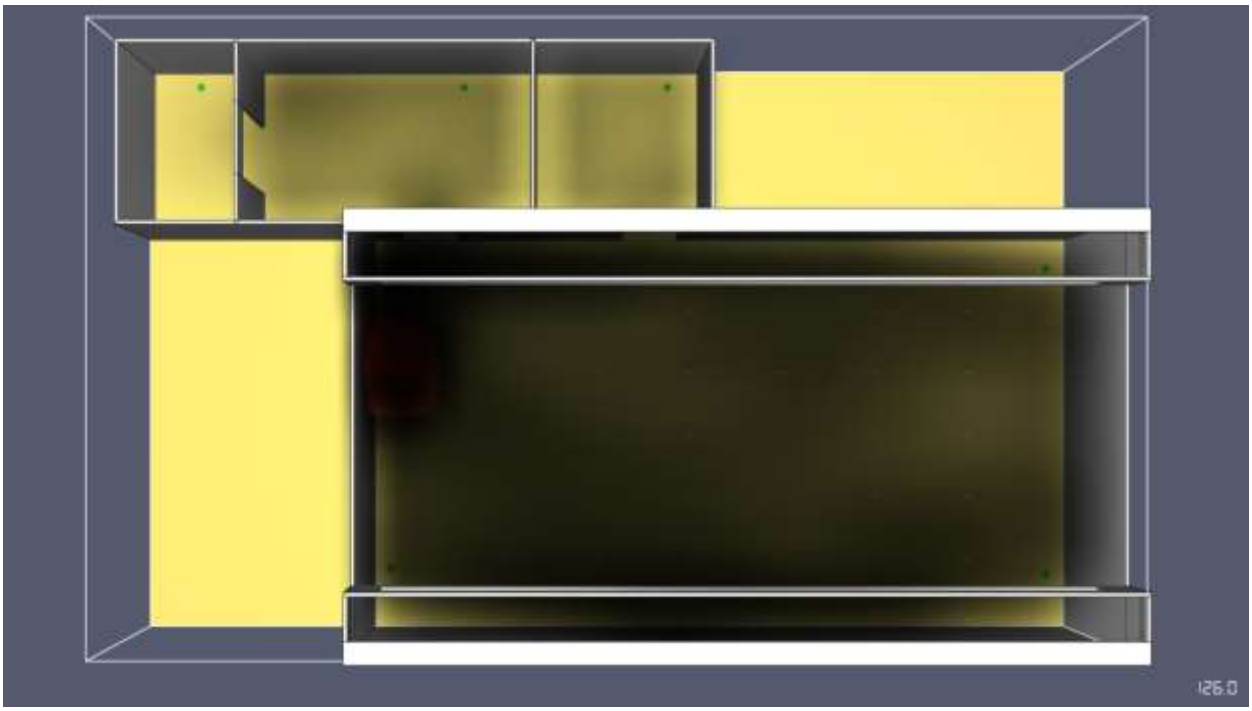


Figure 80: Pallet Fire SmokeView @ 126s - Top View

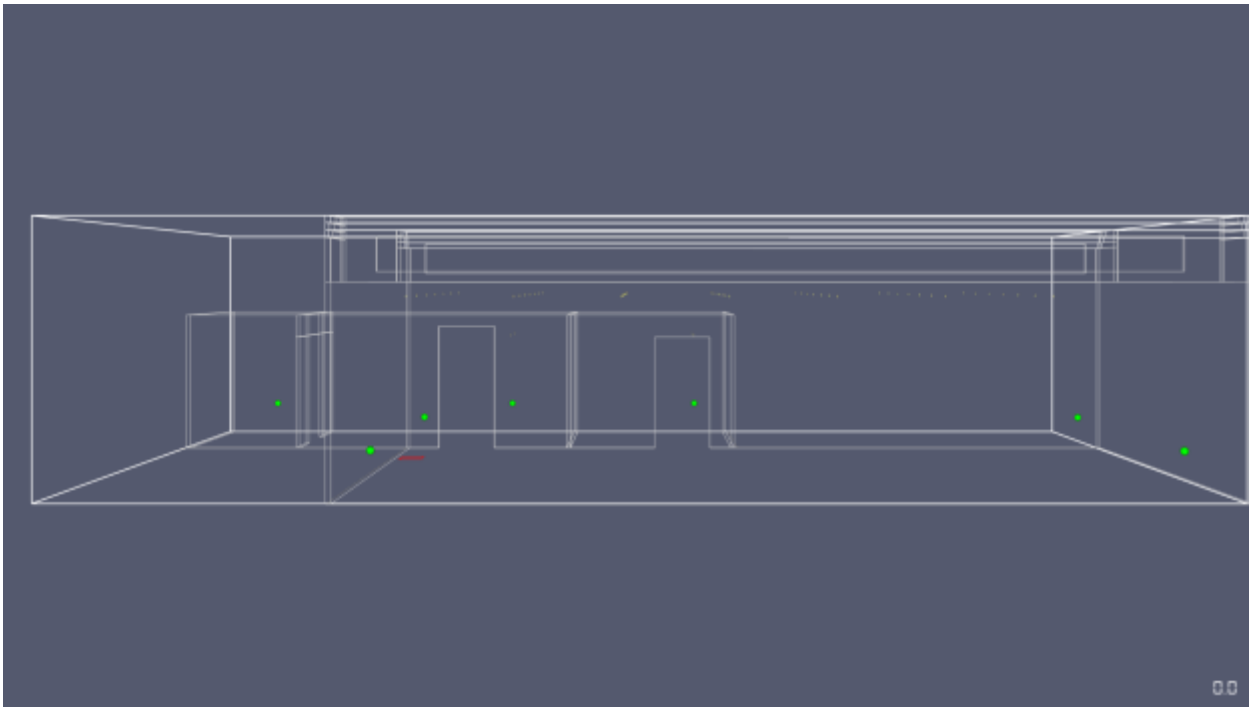


Figure 81: Pallet Fire SmokeView @ 0s - Side View

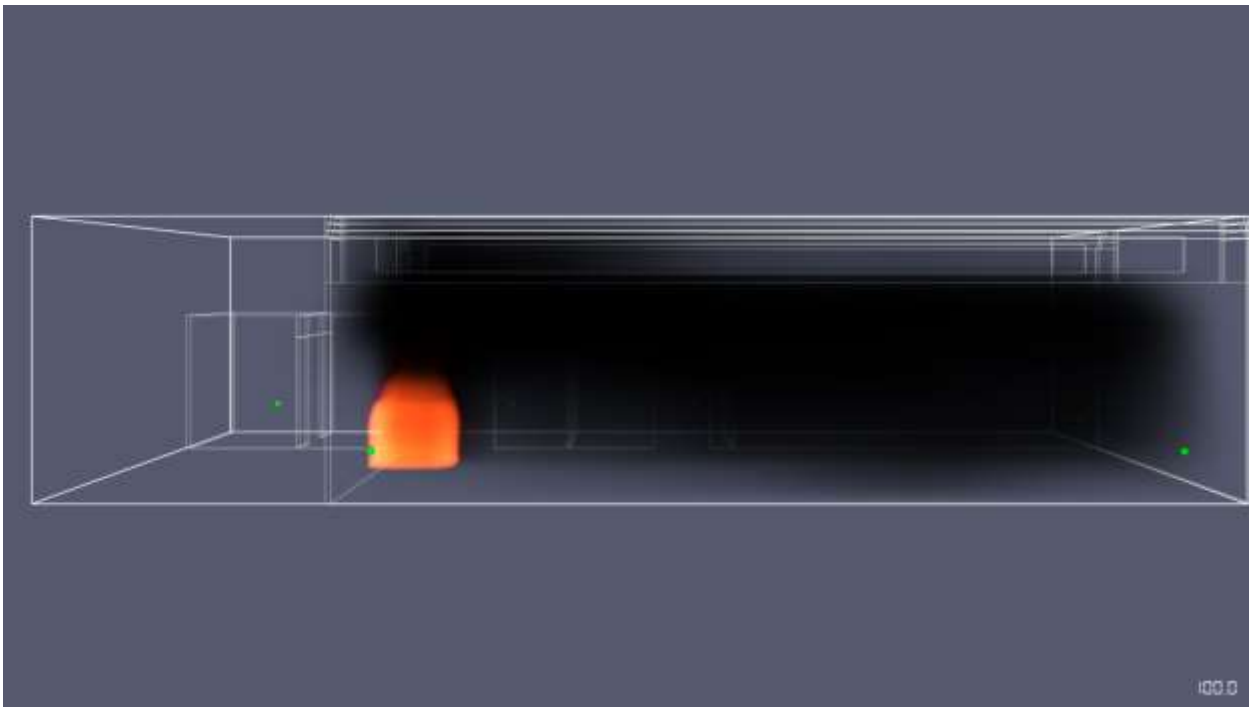


Figure 82: Pallet Fire SmokeView @ 100s - Side View

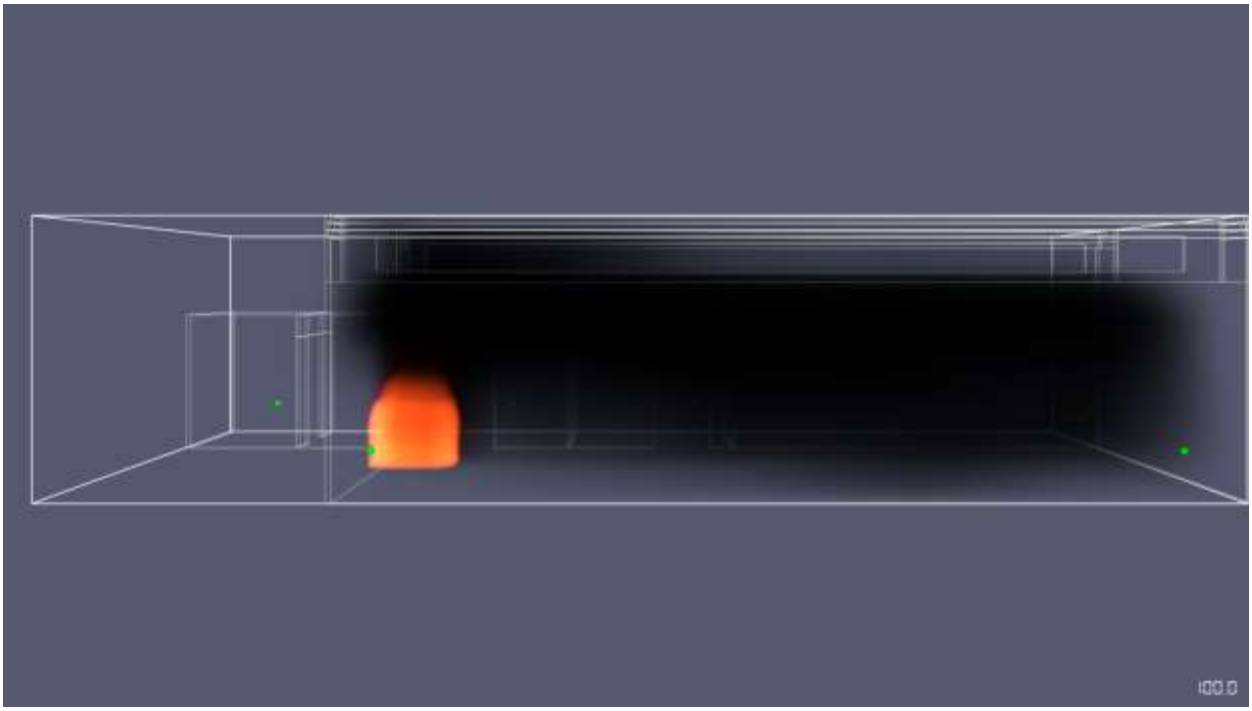


Figure 83: Pallet Fire SmokeView @1260s - Side View

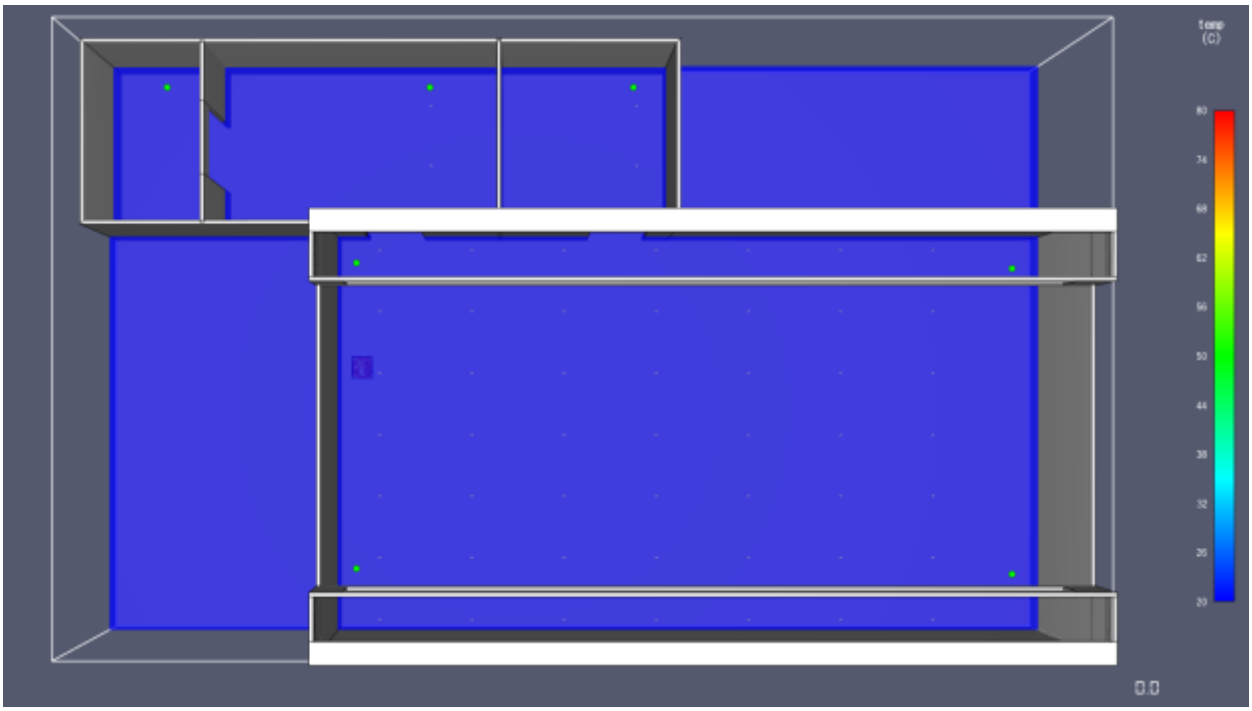


Figure 84: Pallet Fire Temperature Slice @ 0s - Top View

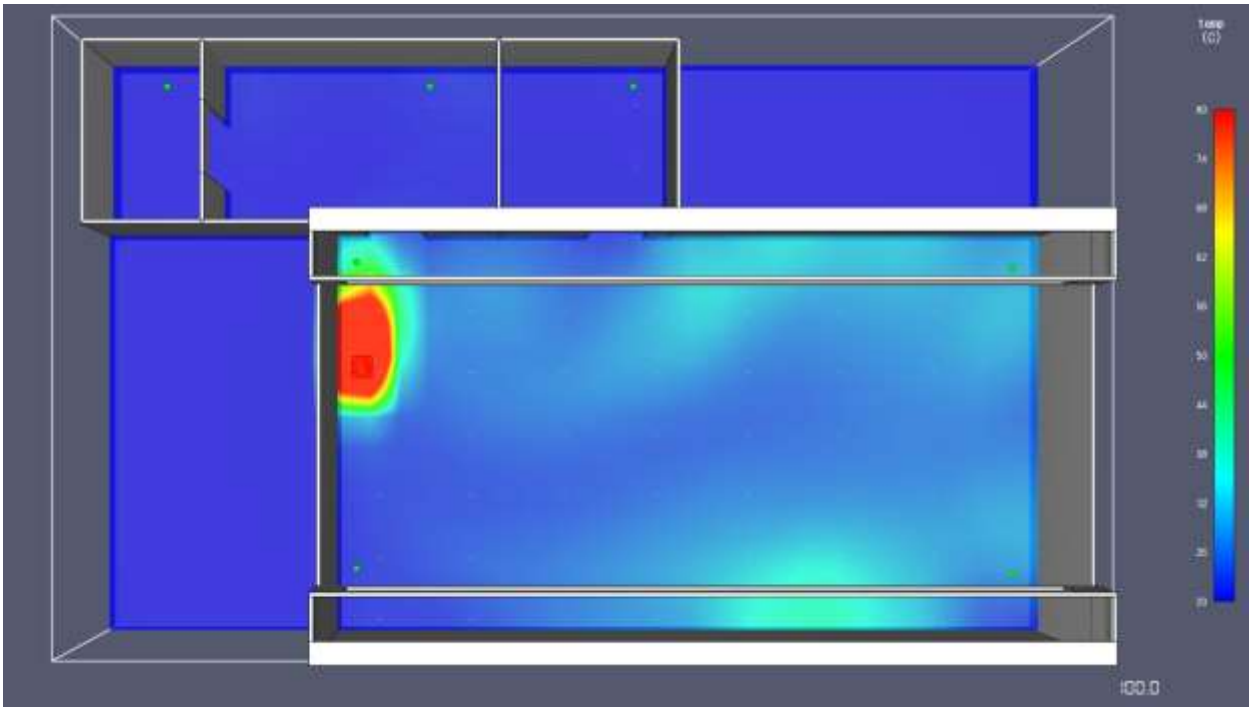


Figure 85: Pallet Fire Temperature Slice @ 100s - Top View

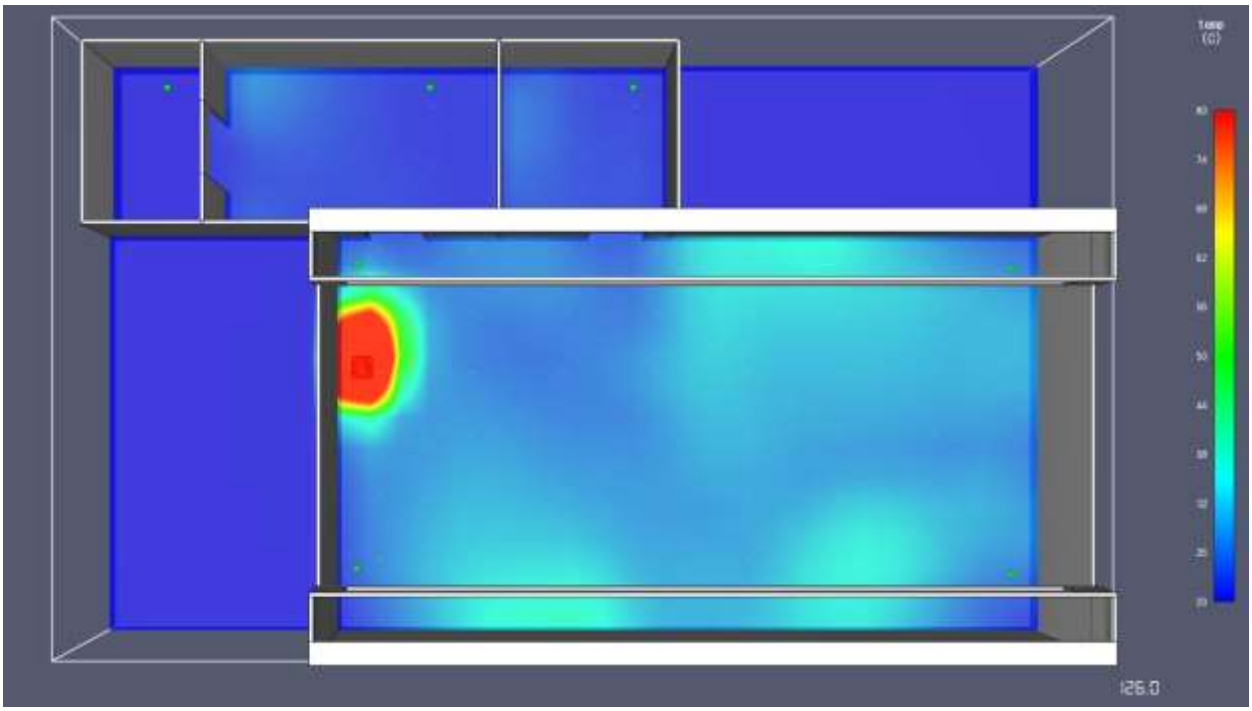


Figure 86: Pallet Fire Temperature Slice @ 126s - Top View

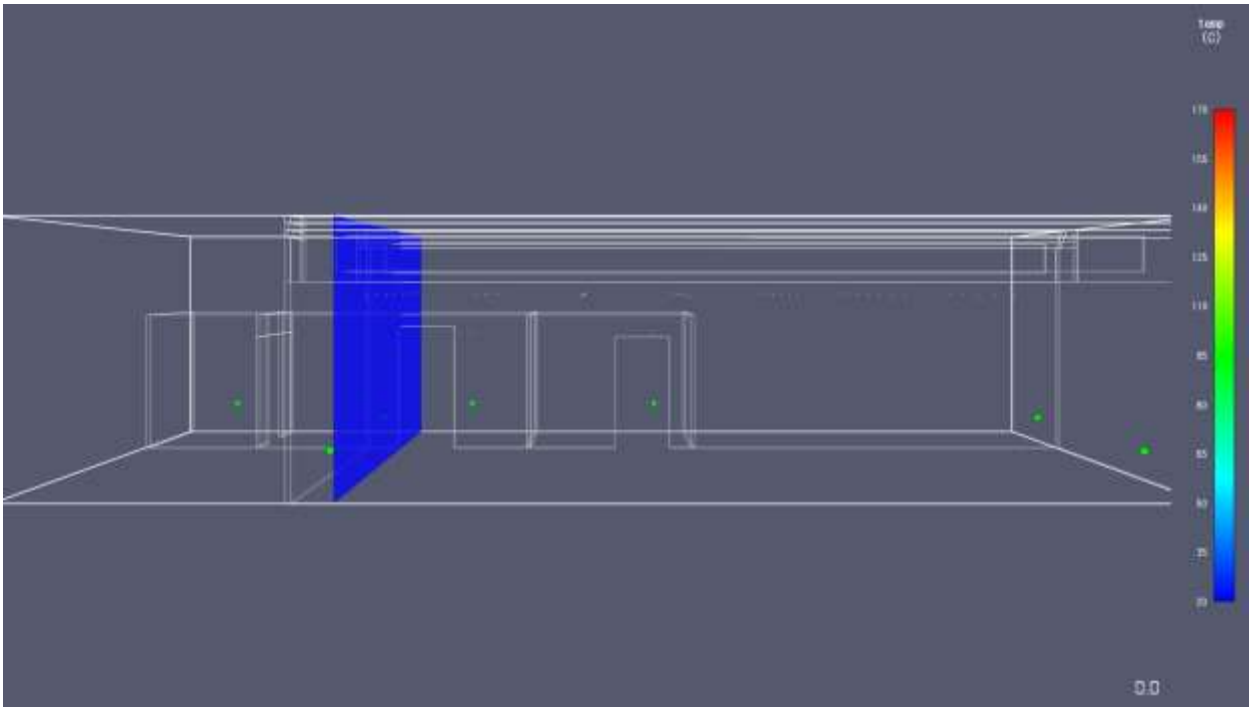


Figure 87: Pallet Fire Temperature Slice @ 0s - View from West

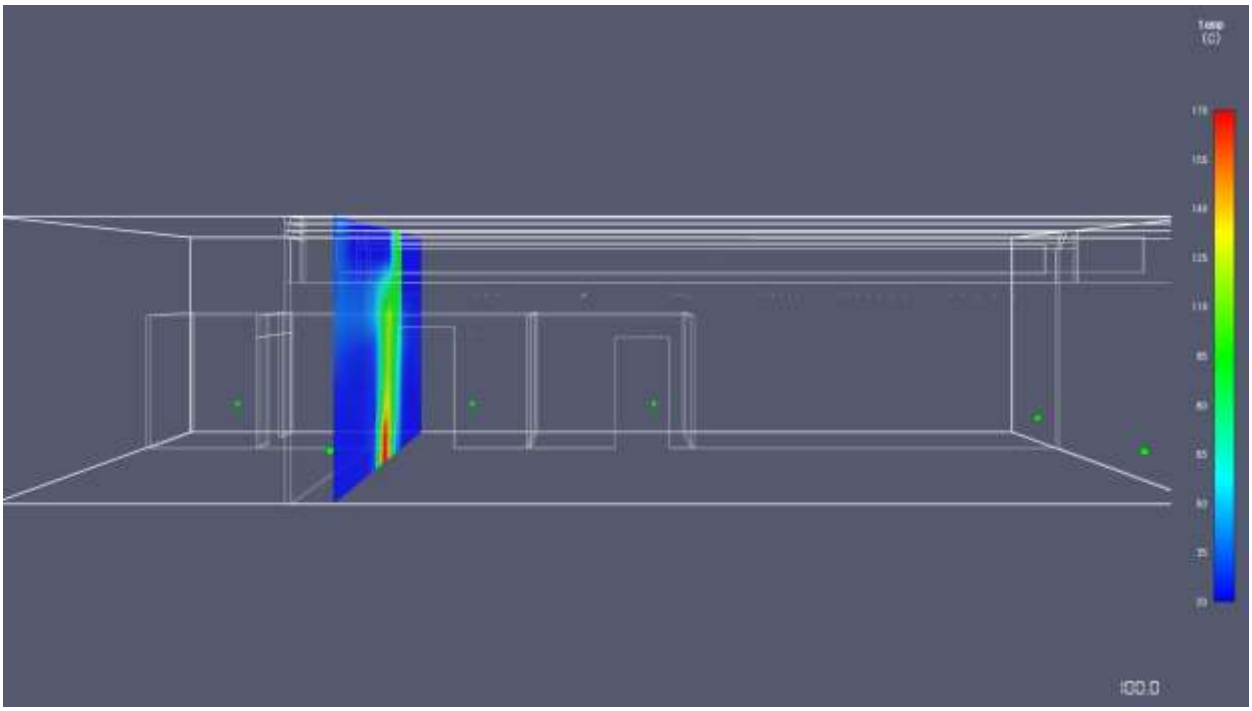


Figure 88: Pallet Fire Temperature Slice @ 100s - View from West

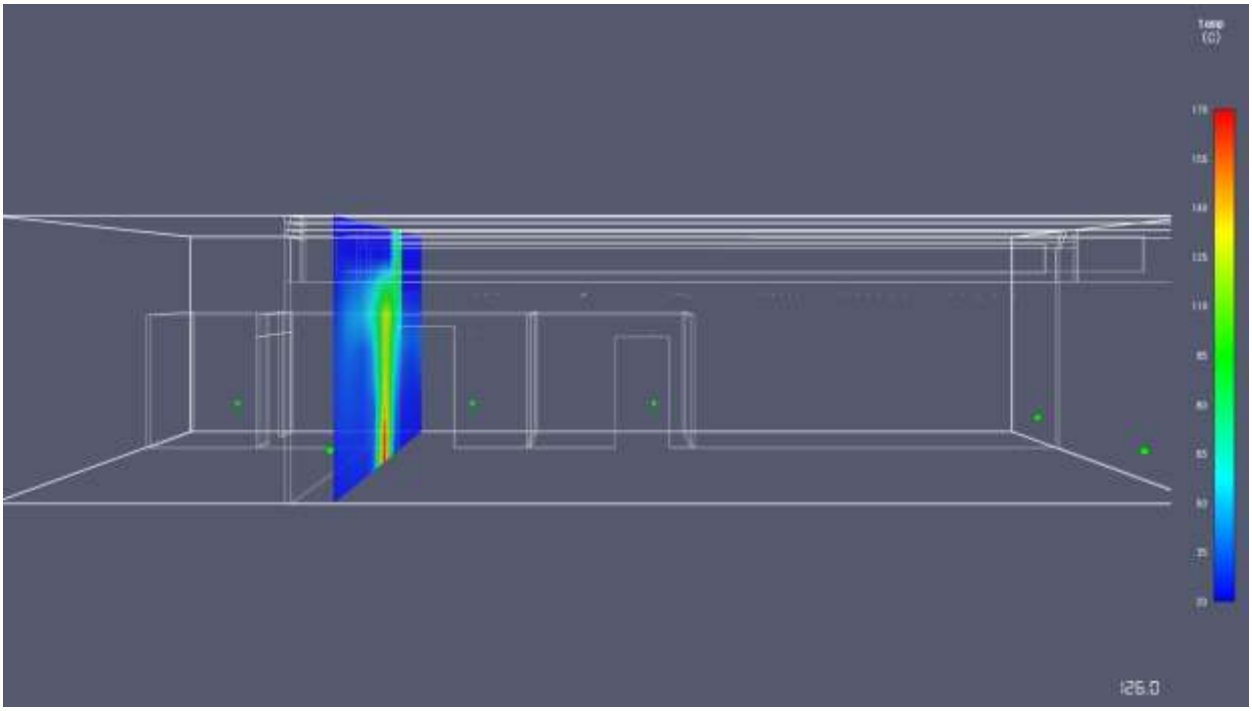


Figure 89: Pallet Fire Temperature Slice @ 126s - View from West

Appendix N: Office Fire Simulation

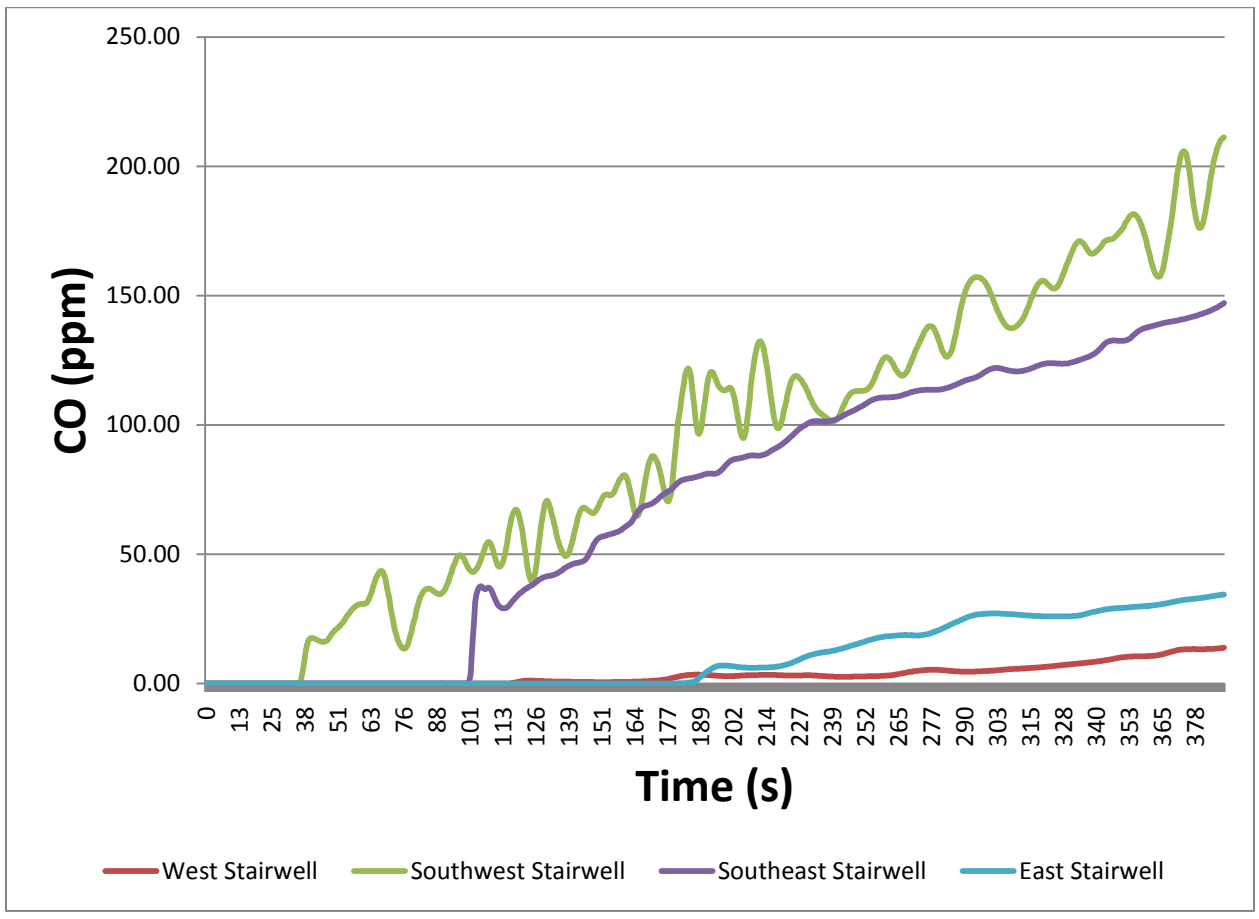


Figure 90: Office Fire Stairwell CO ppm vs. Time

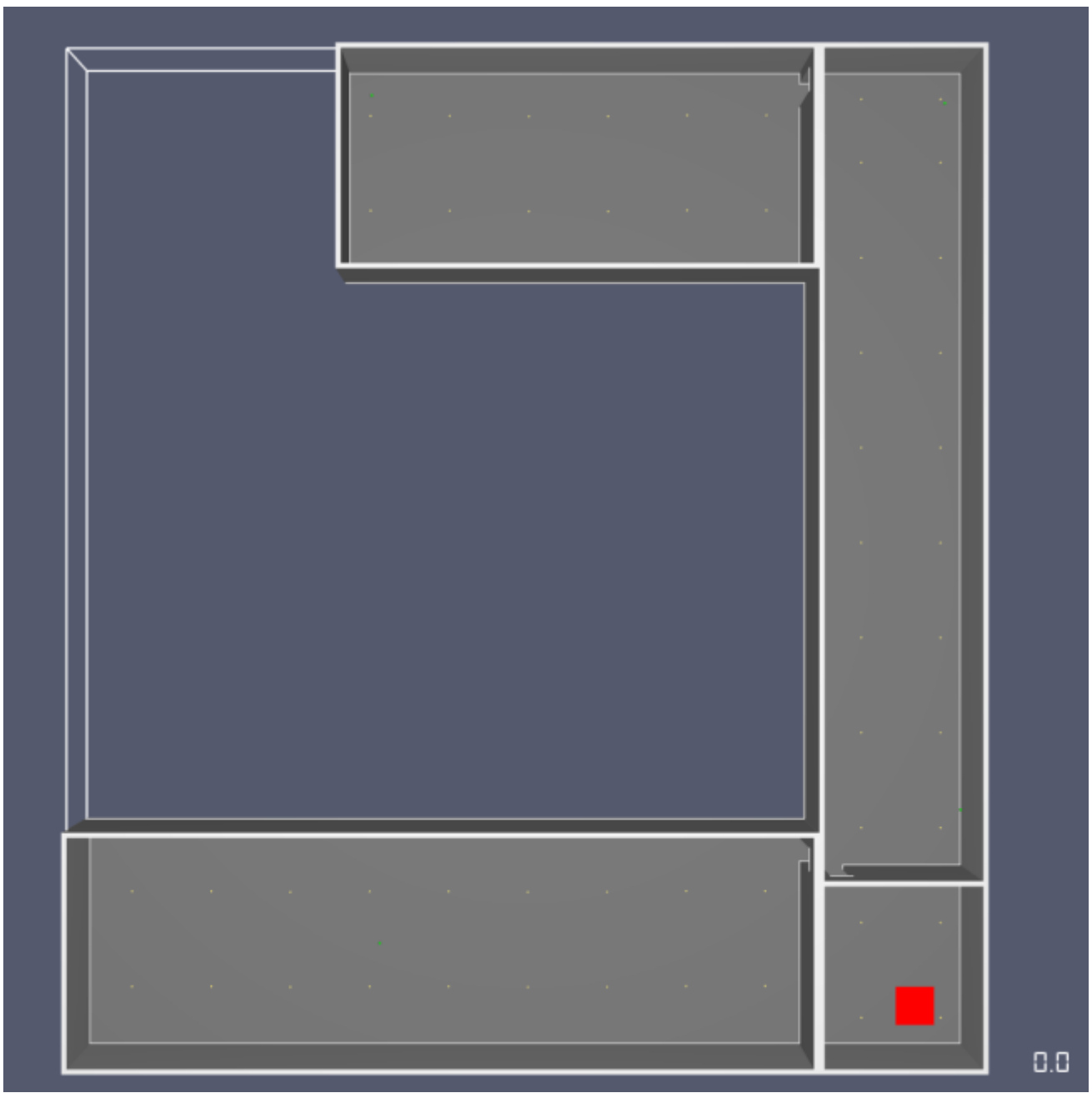


Figure 91: Office Fire SmokeView @ 0s - Top View

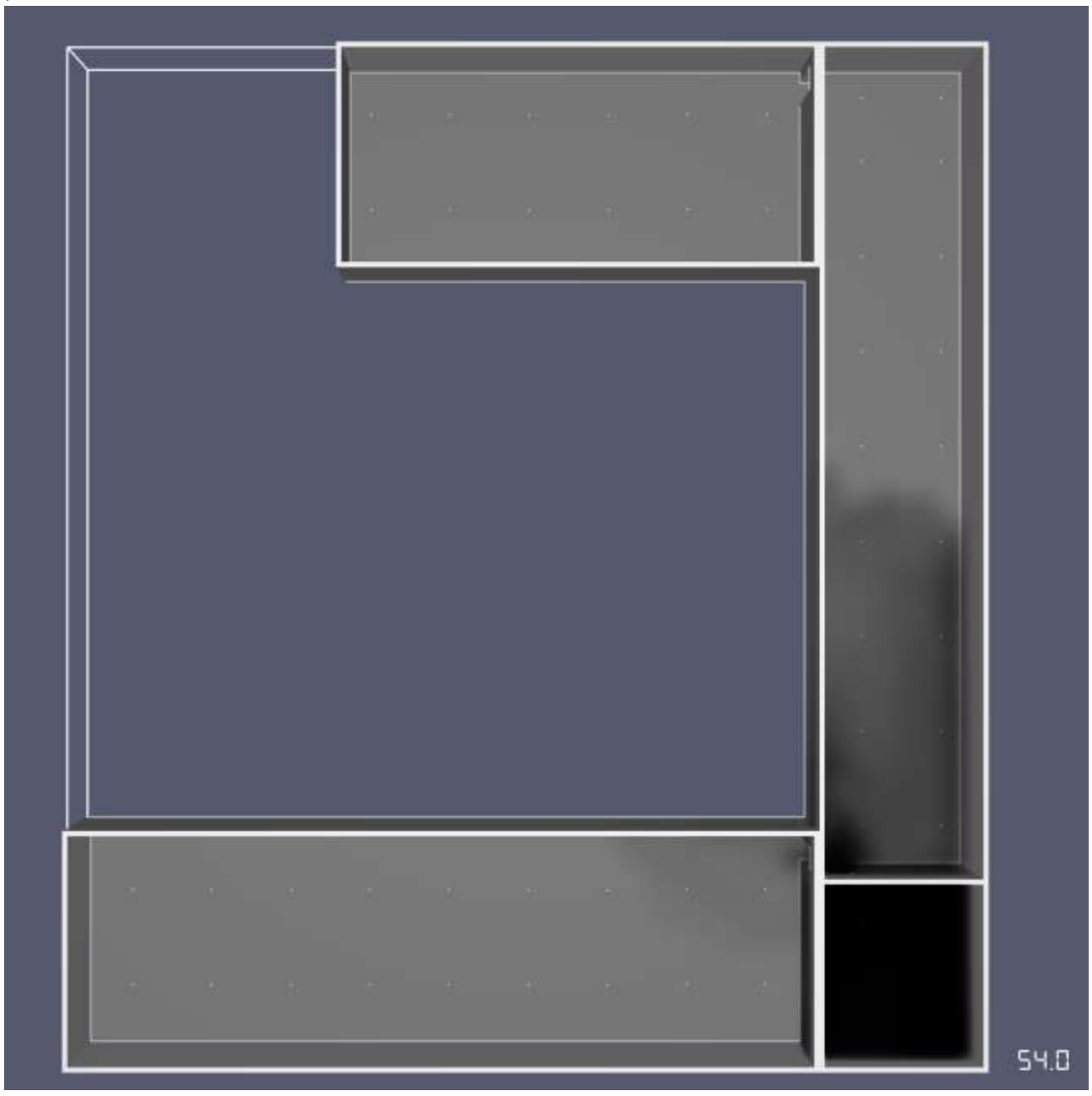


Figure 92: Office Fire SmokeView @ 54s - Top View

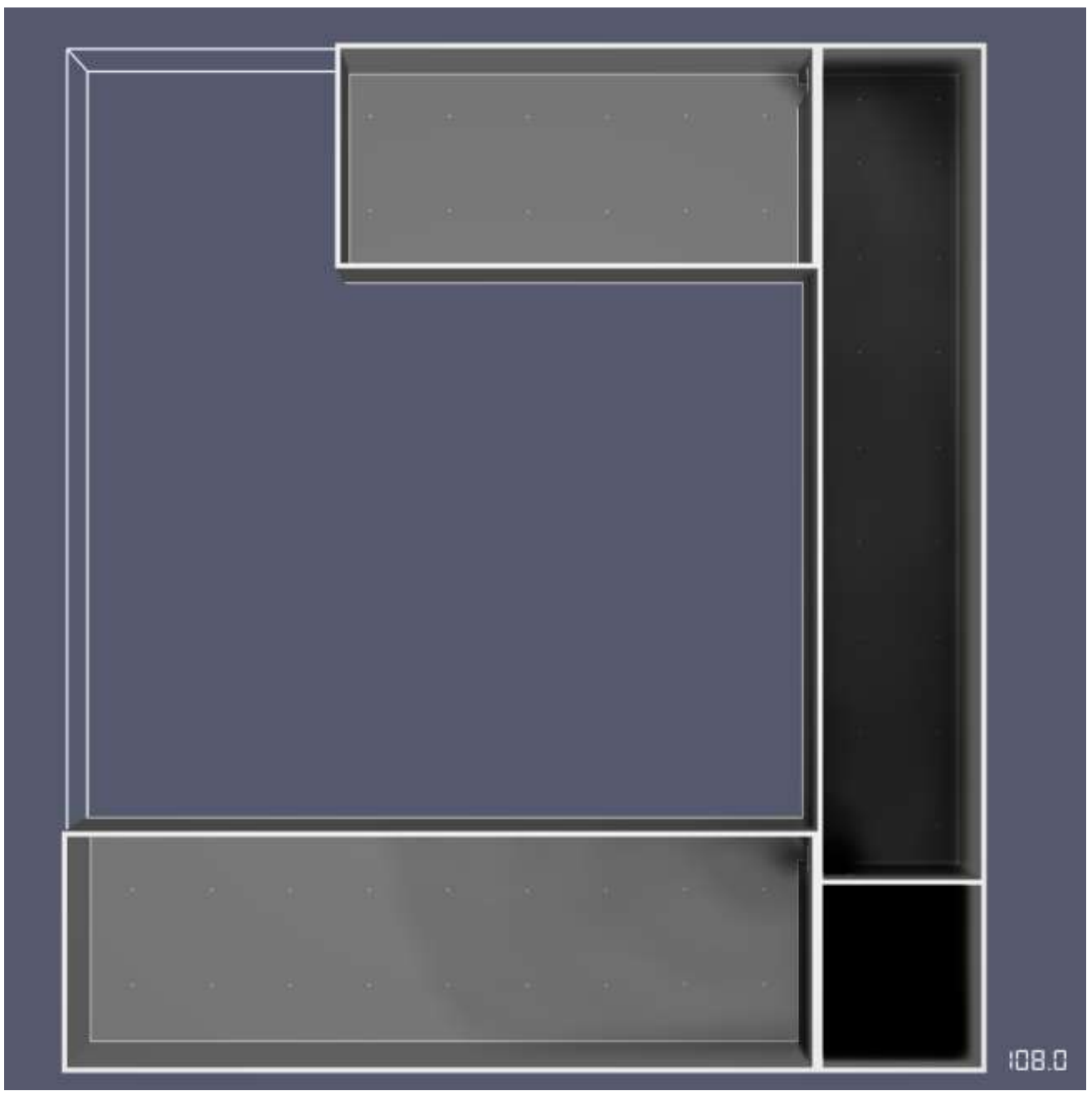


Figure 93: Office Fire SmokeView @ 108s - Top View

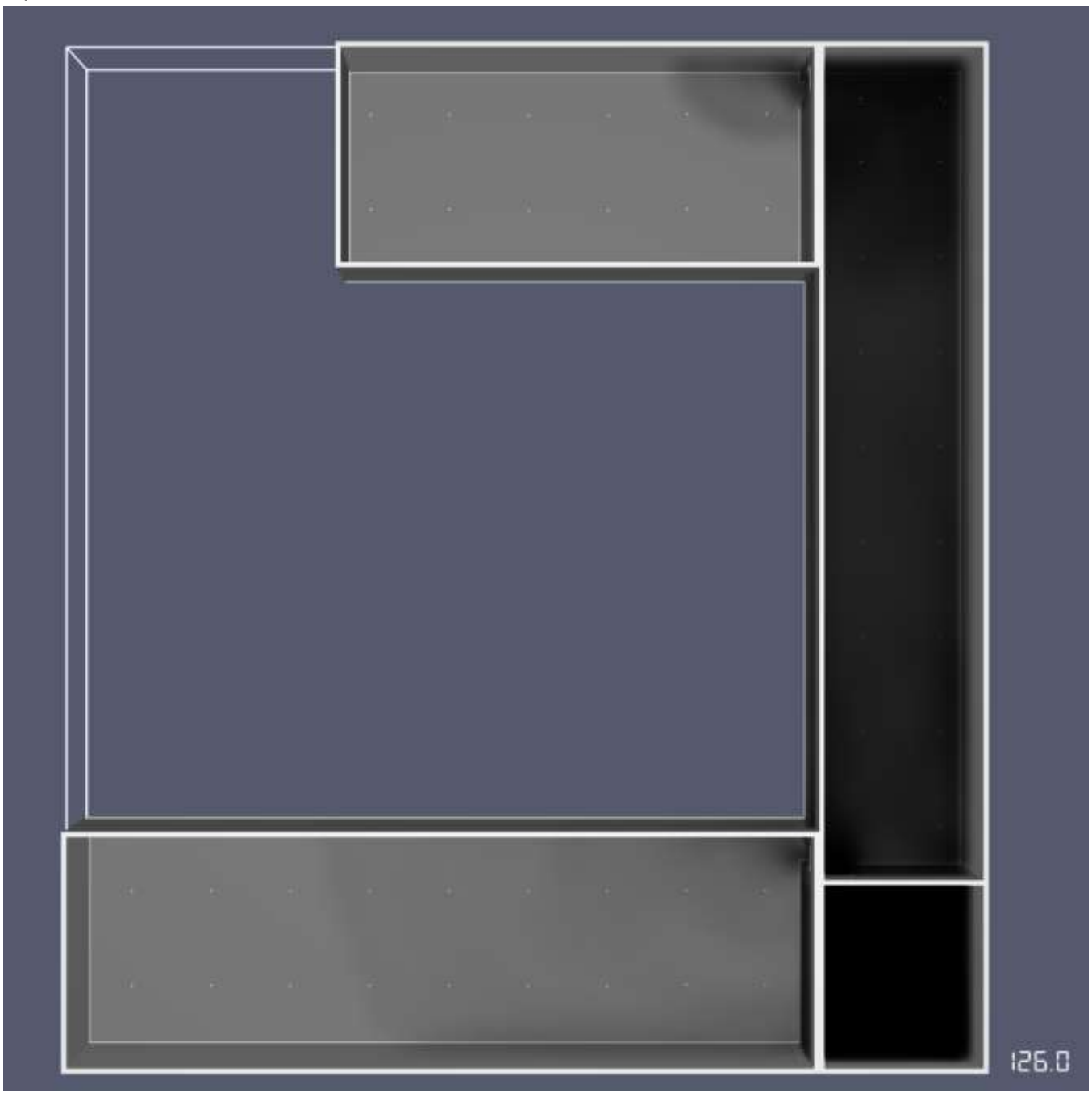


Figure 94: Office Fire SmokeView @ 180s - Top View

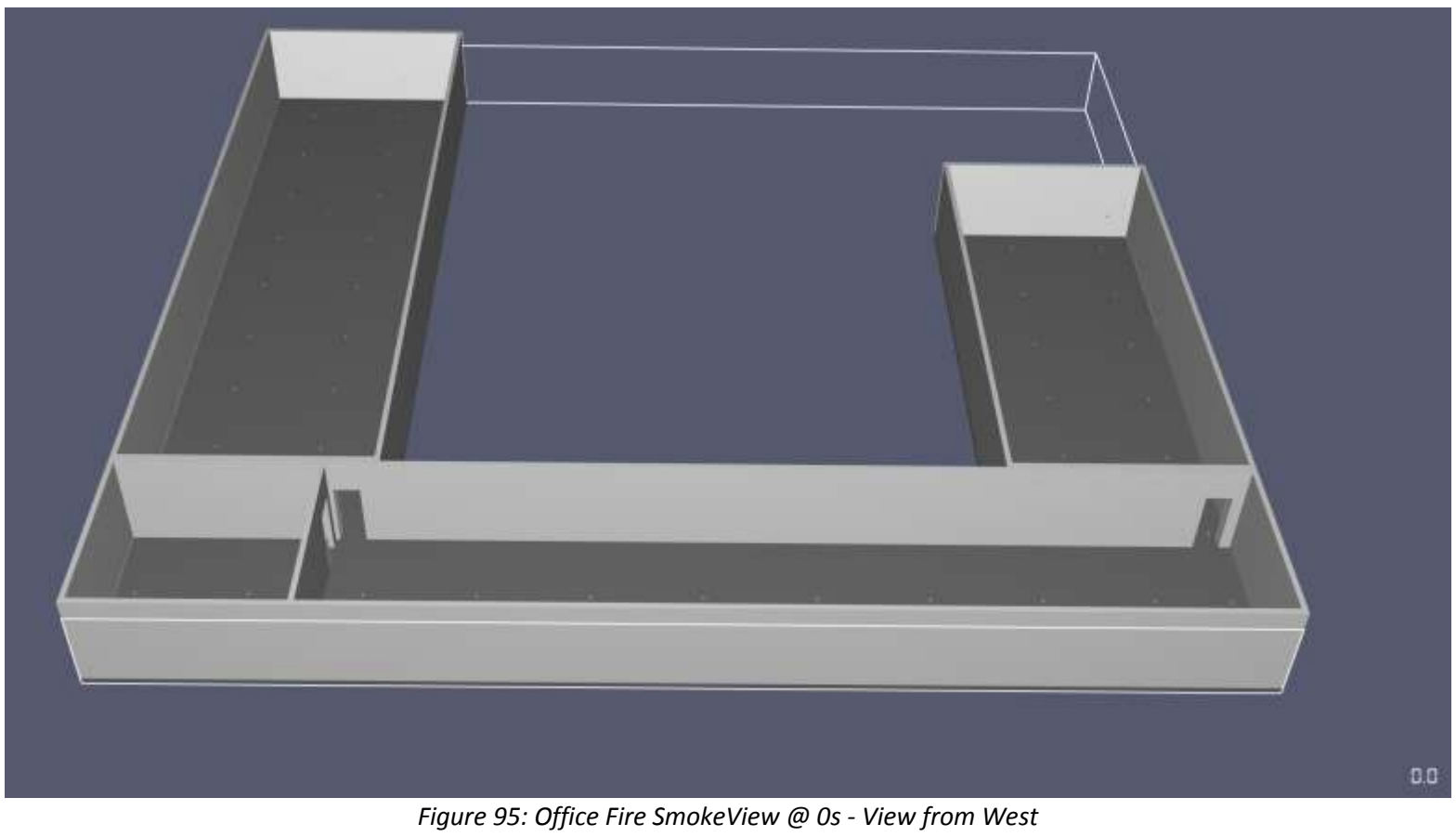


Figure 95: Office Fire SmokeView @ 0s - View from West

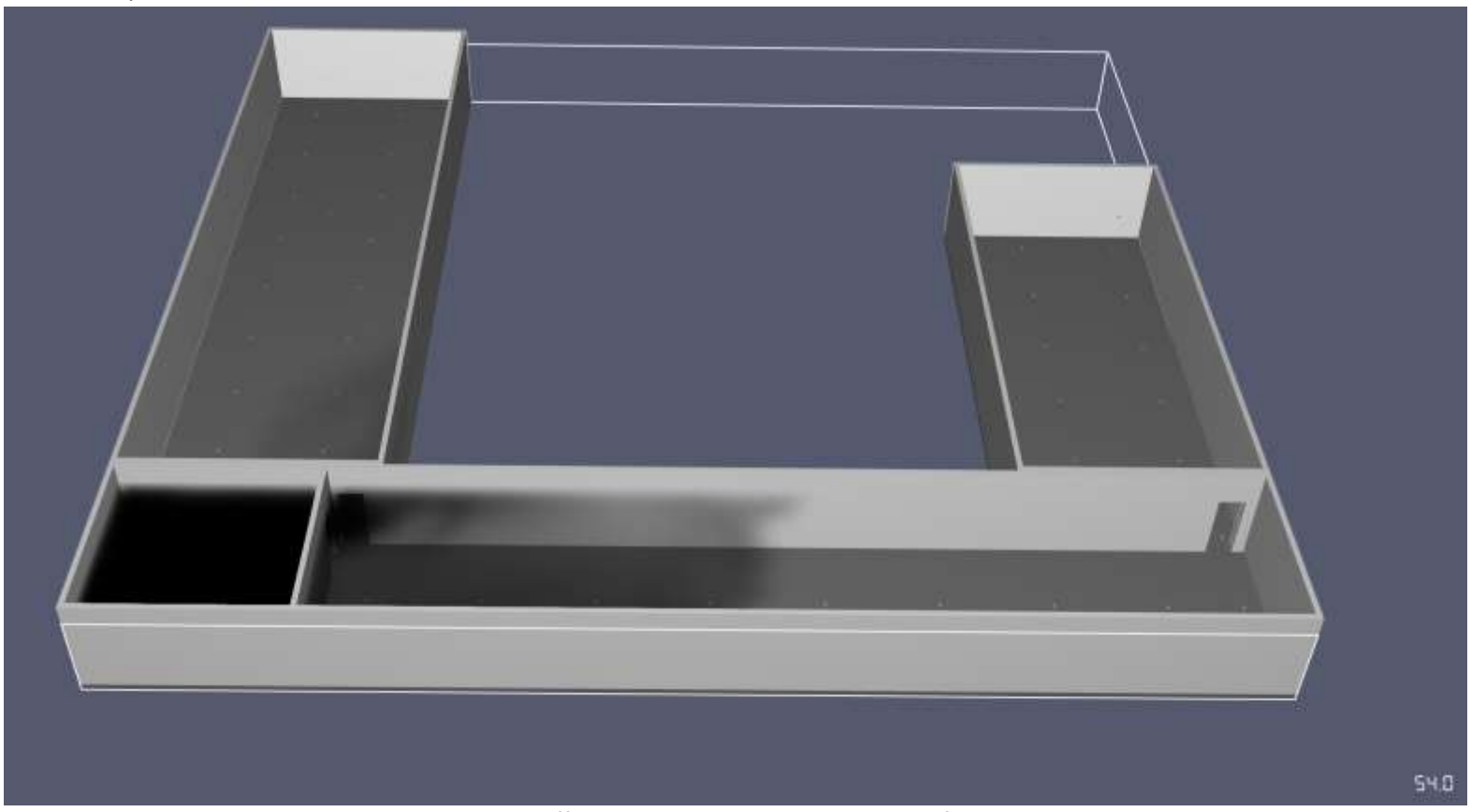


Figure 96: Office Fire SmokeView @ 54s - View from West

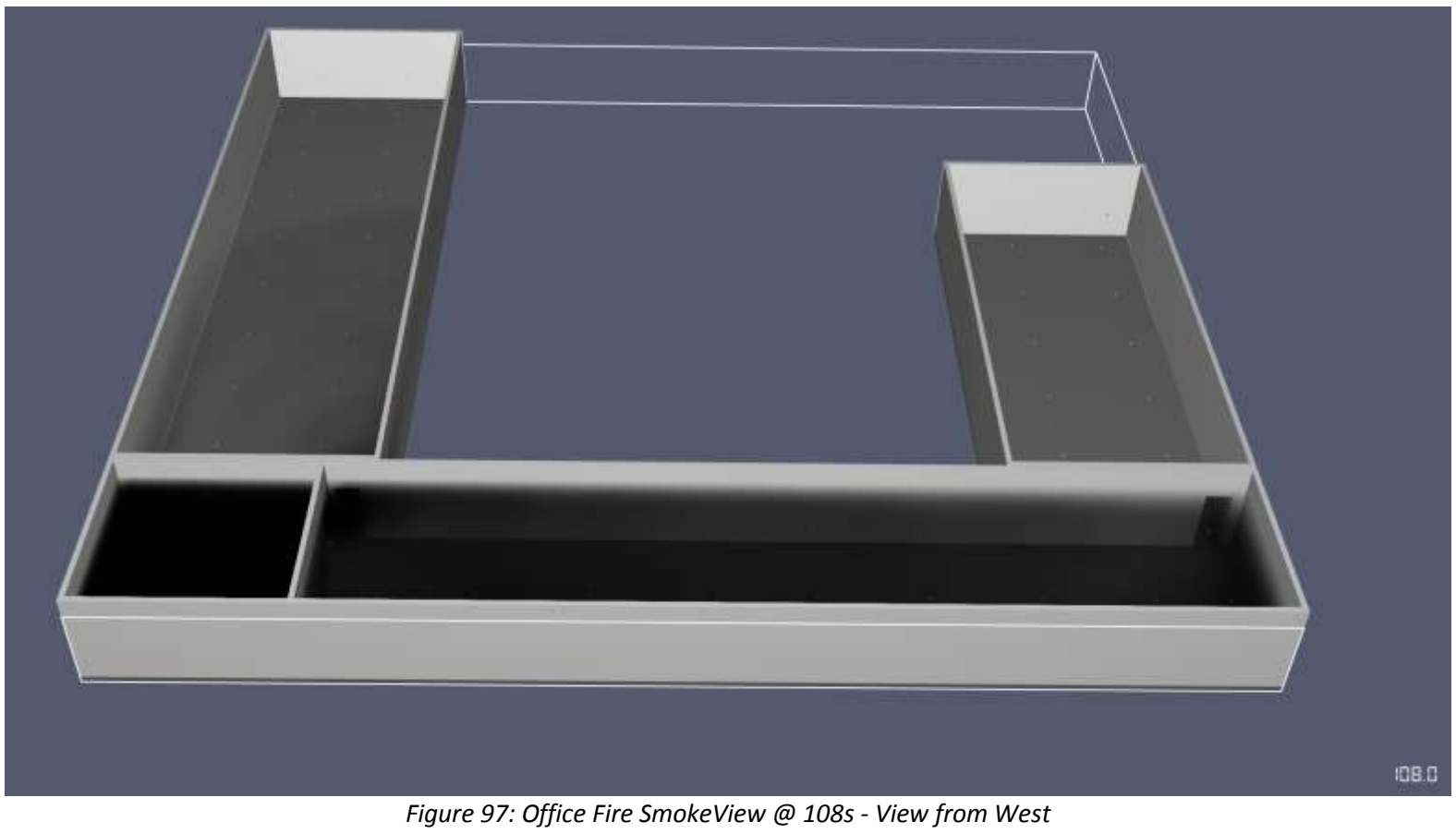


Figure 97: Office Fire SmokeView @ 108s - View from West

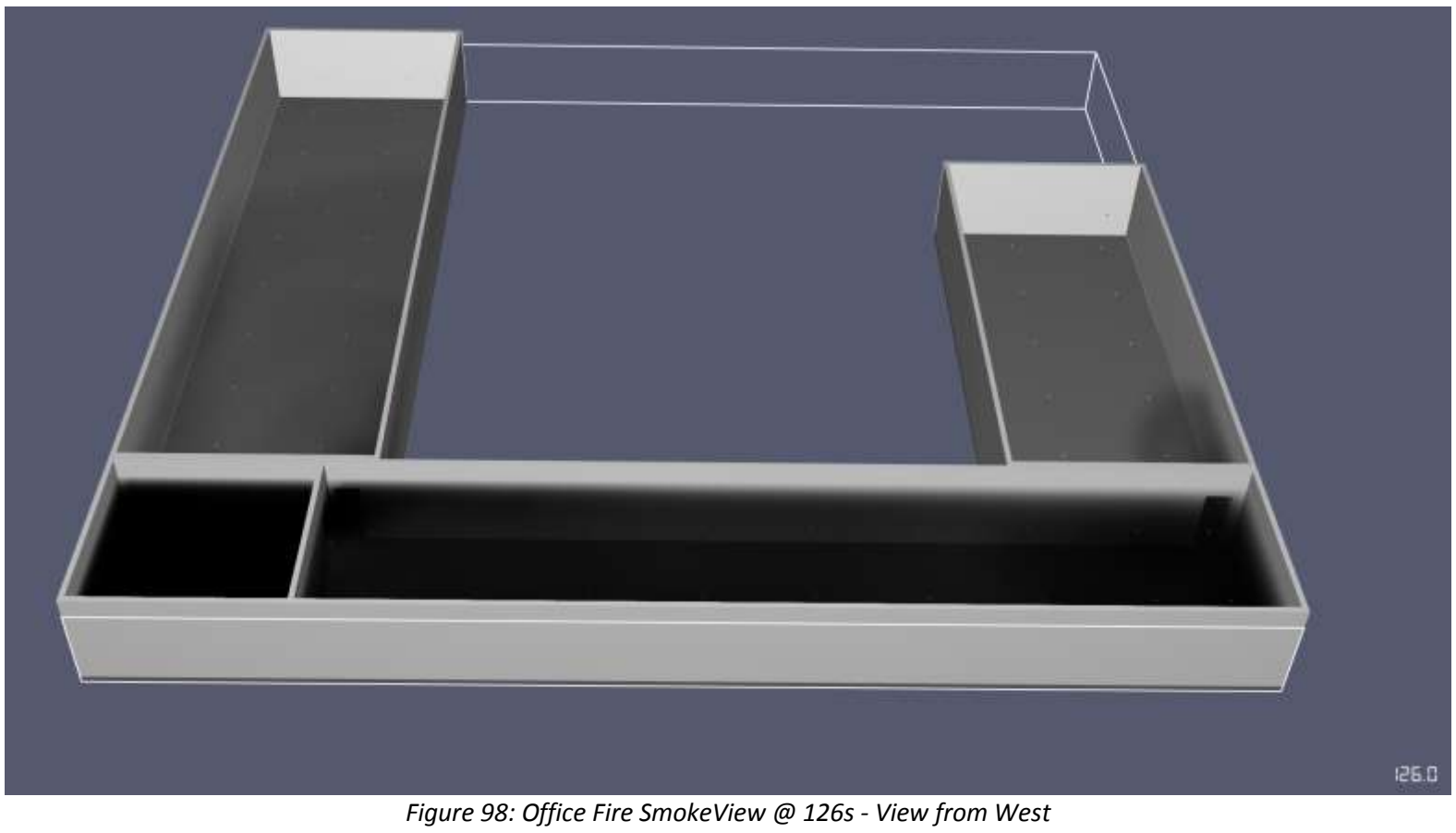


Figure 98: Office Fire SmokeView @ 126s - View from West

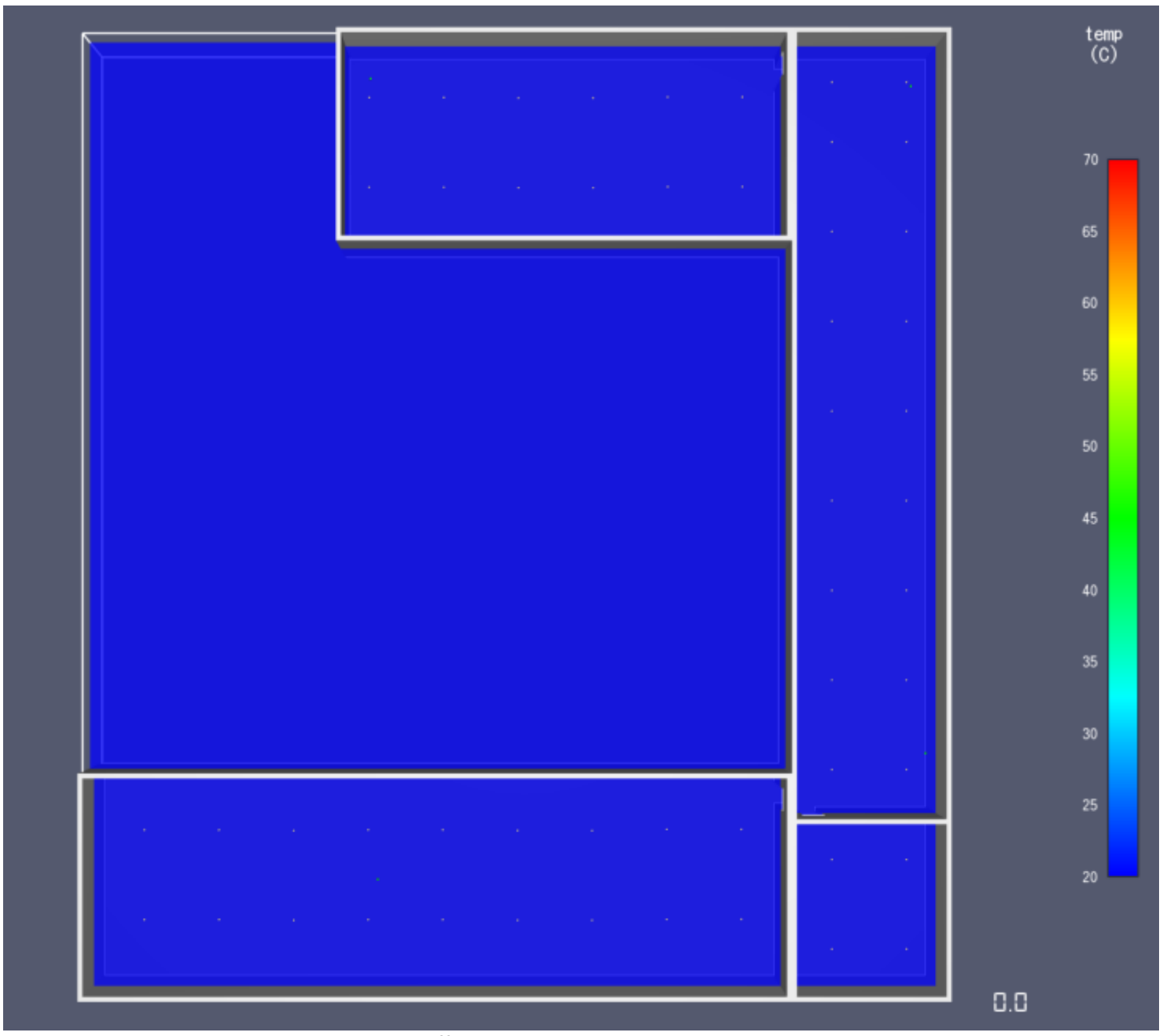


Figure 99: Office Fire Temperature Slice @ 0s - Top View

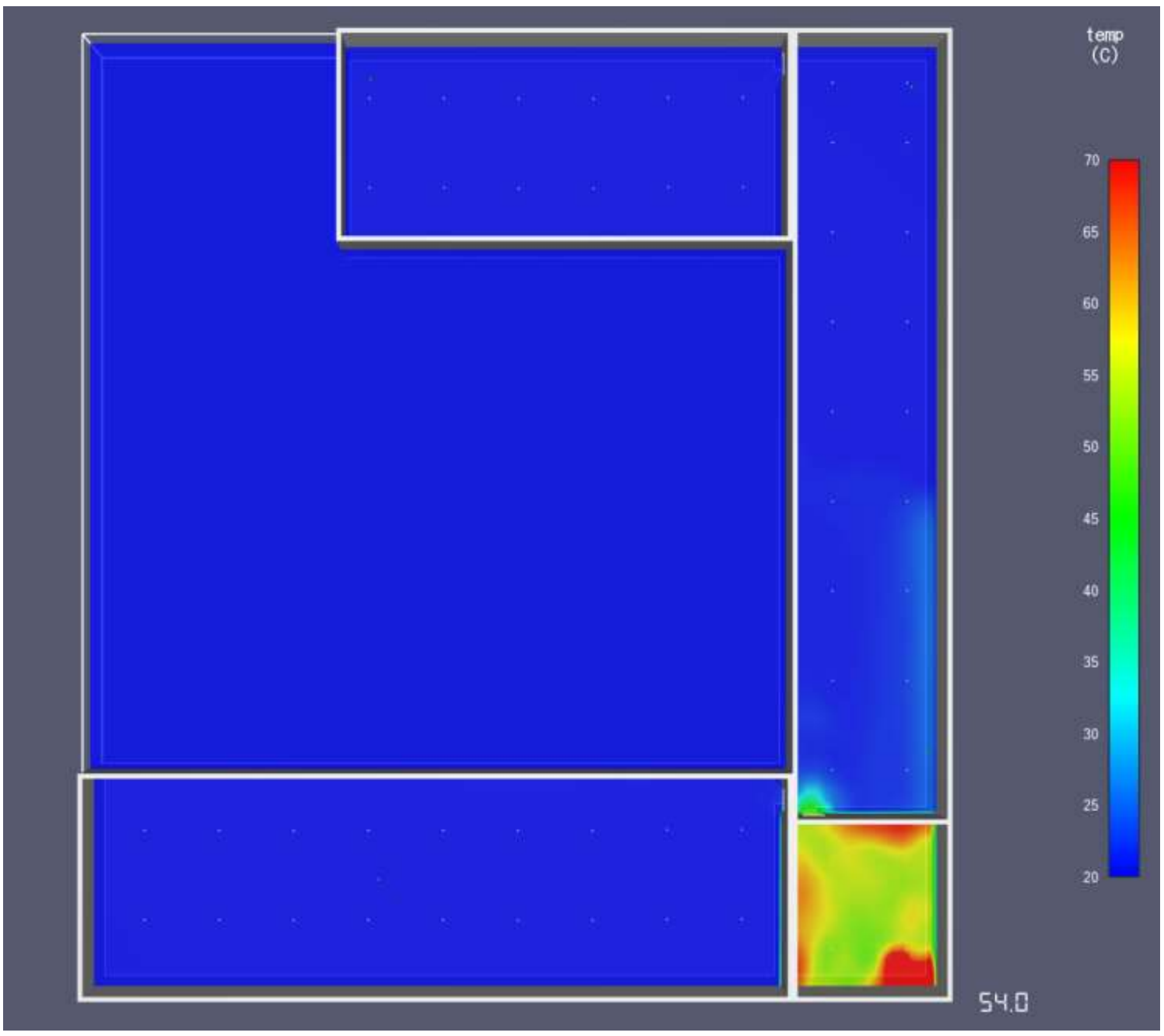


Figure 100: Office Fire Temperature Slice @ 54s - Top View

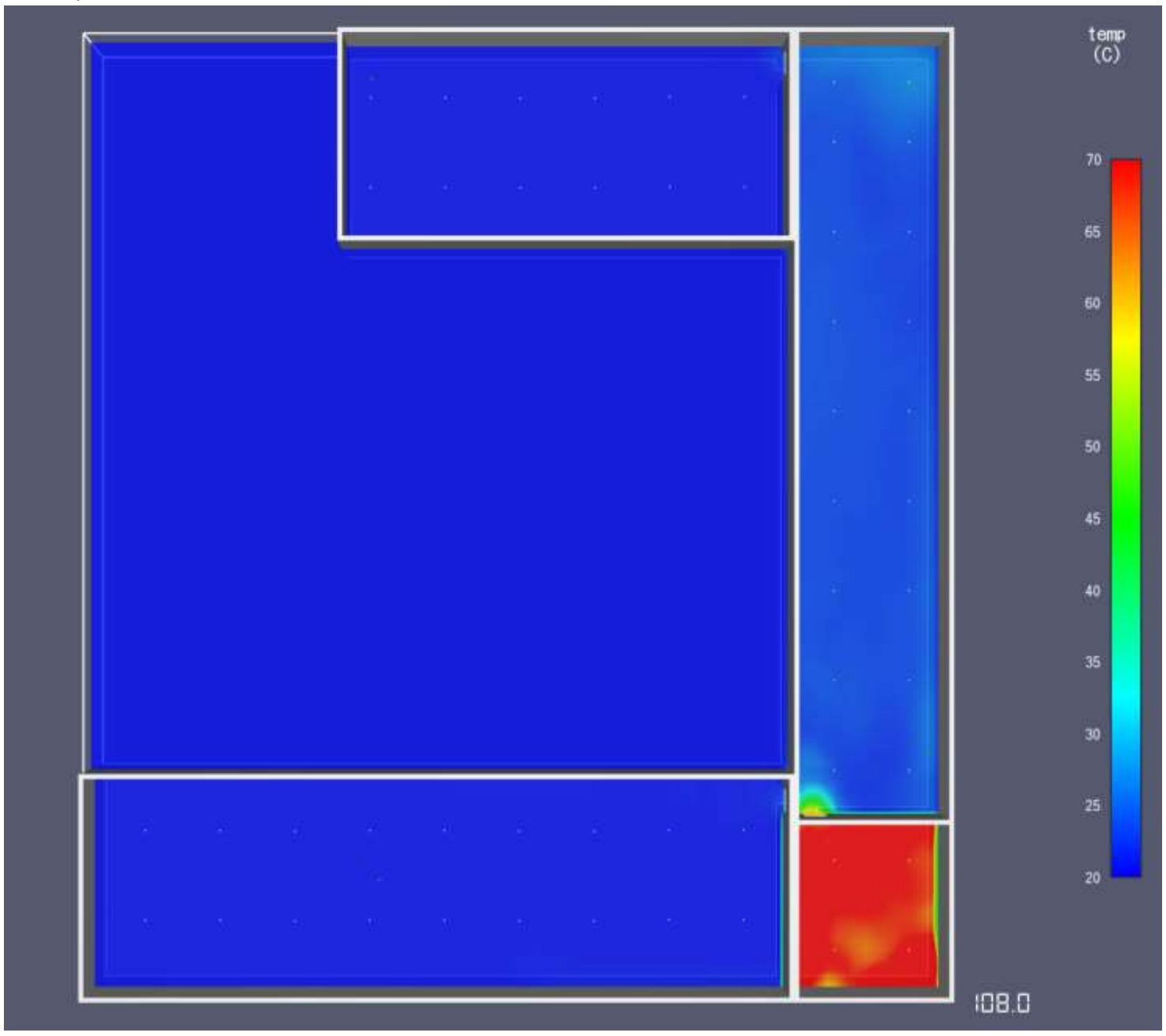


Figure 101: Office Fire Temperature Slice @ 108s - Top View

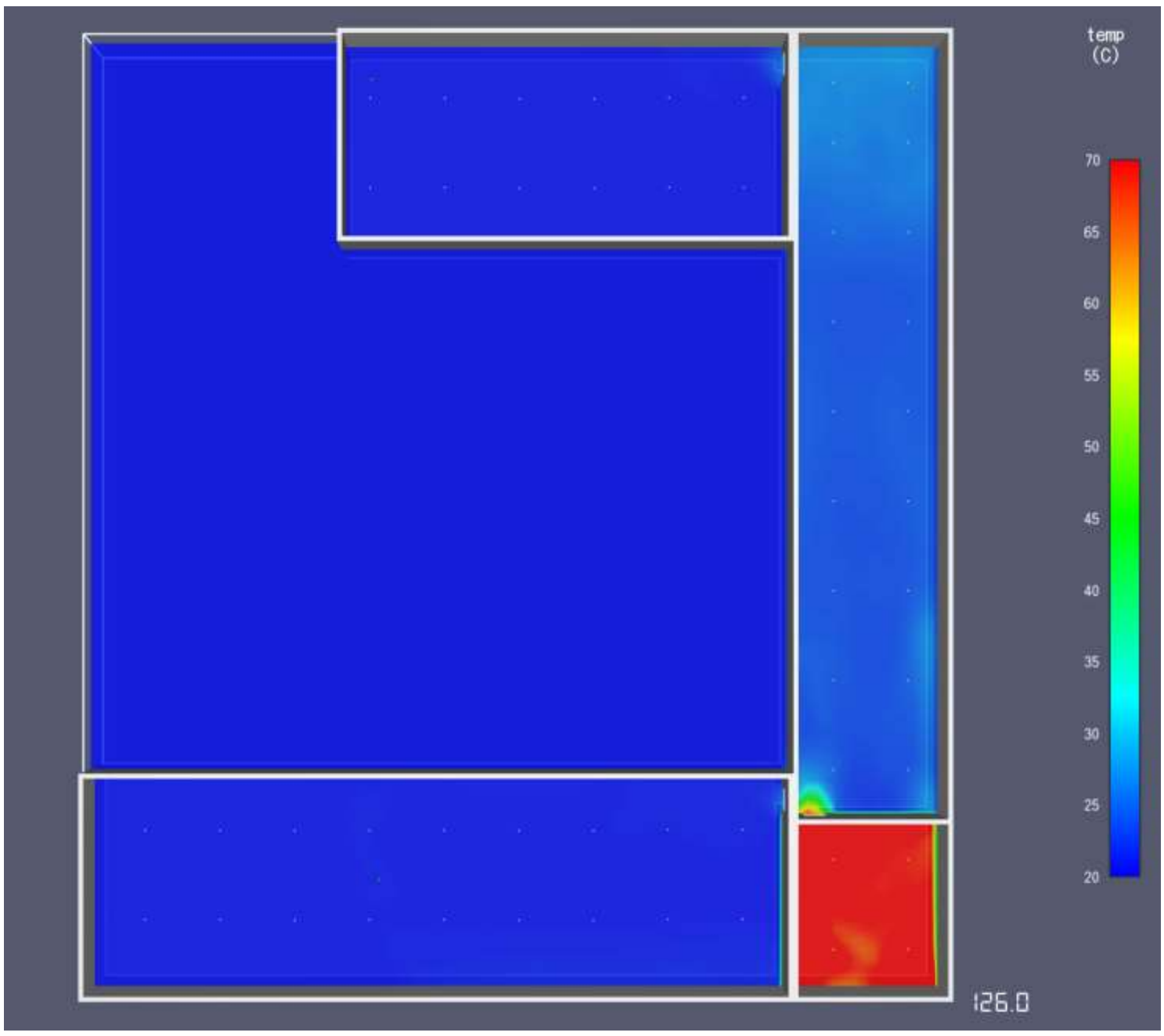


Figure 102: Office Fire Temperature Slice @ 126s - Top View

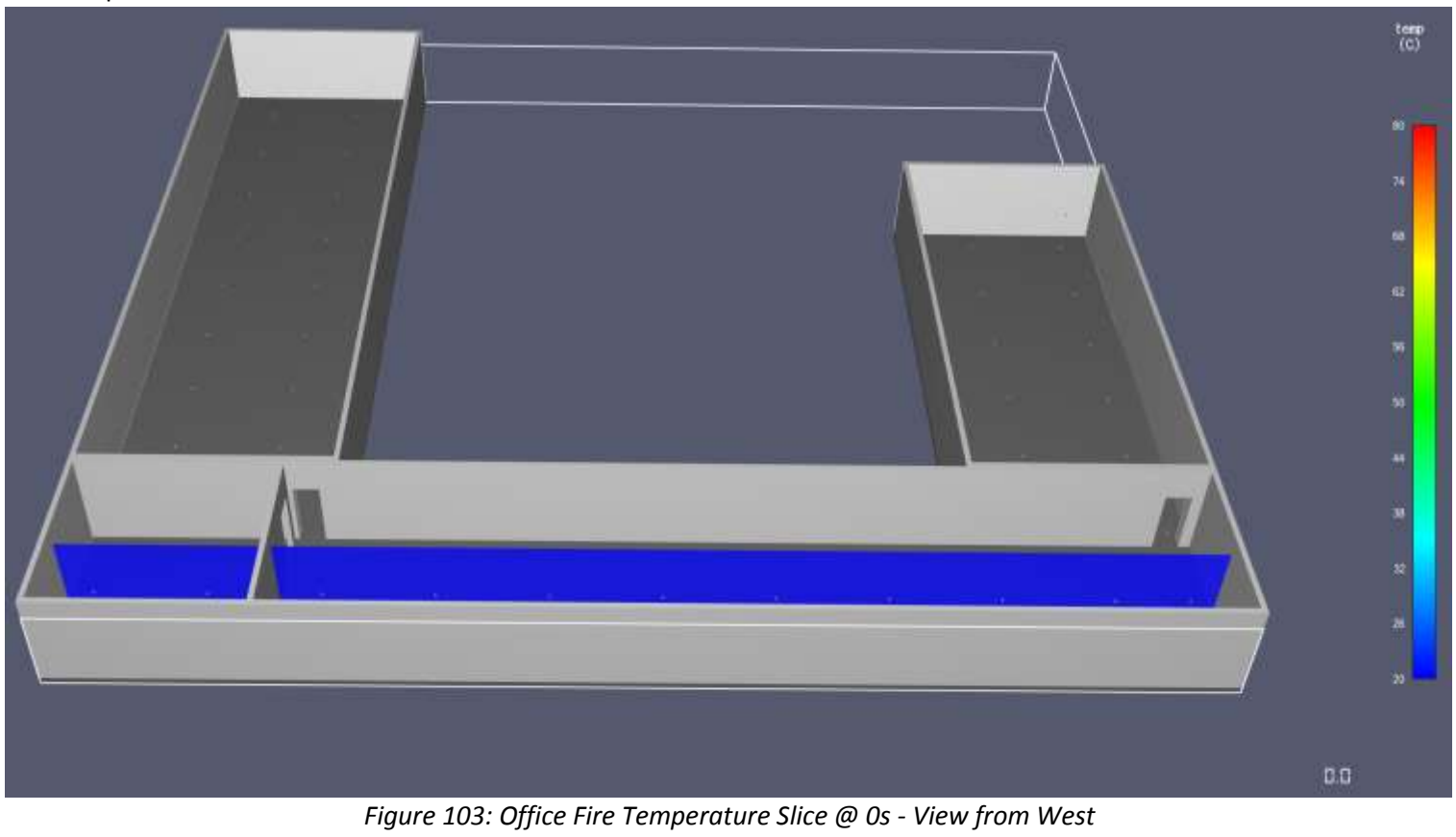


Figure 103: Office Fire Temperature Slice @ 0s - View from West

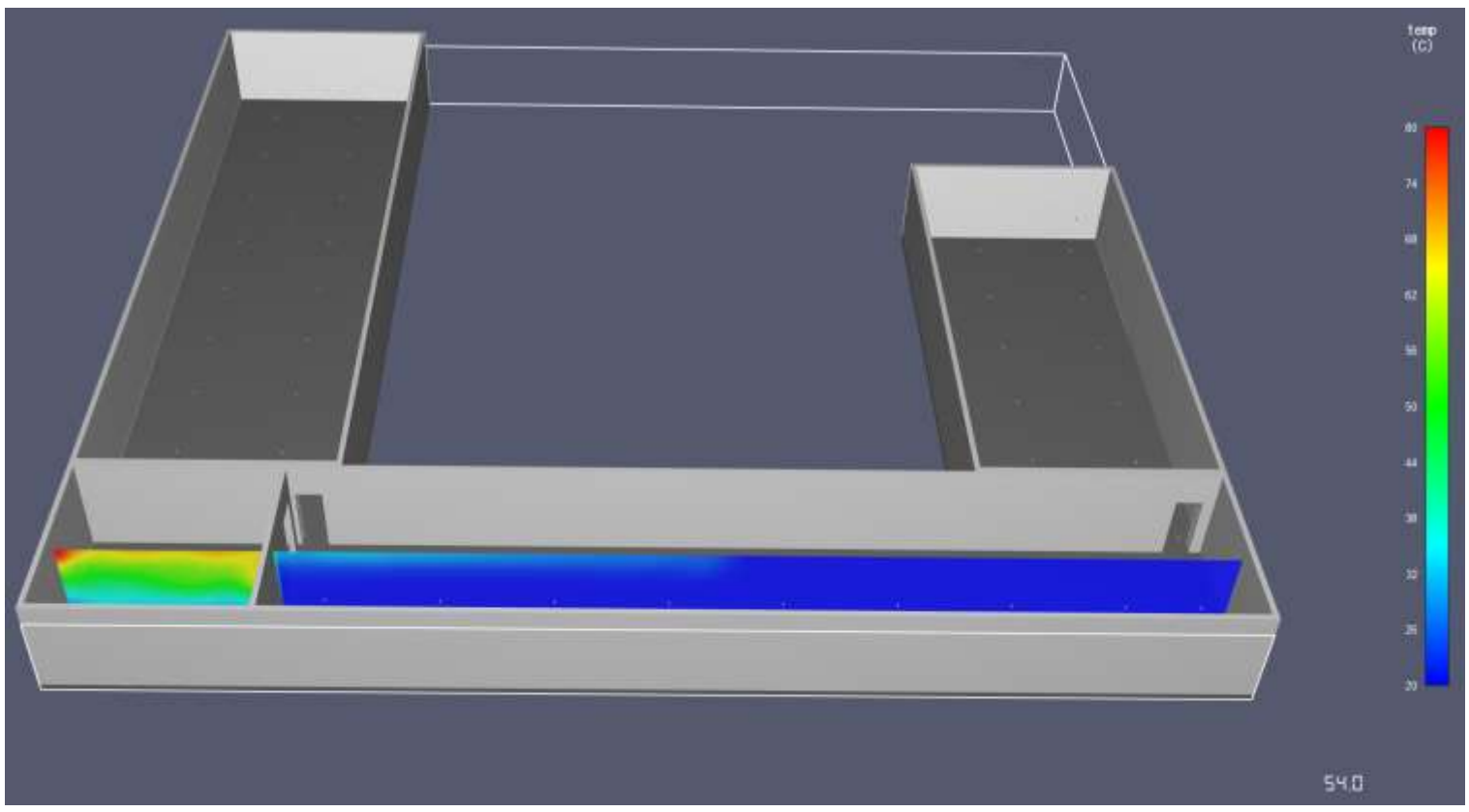


Figure 104: Office Fire Temperature Slice @ 54s - View from West

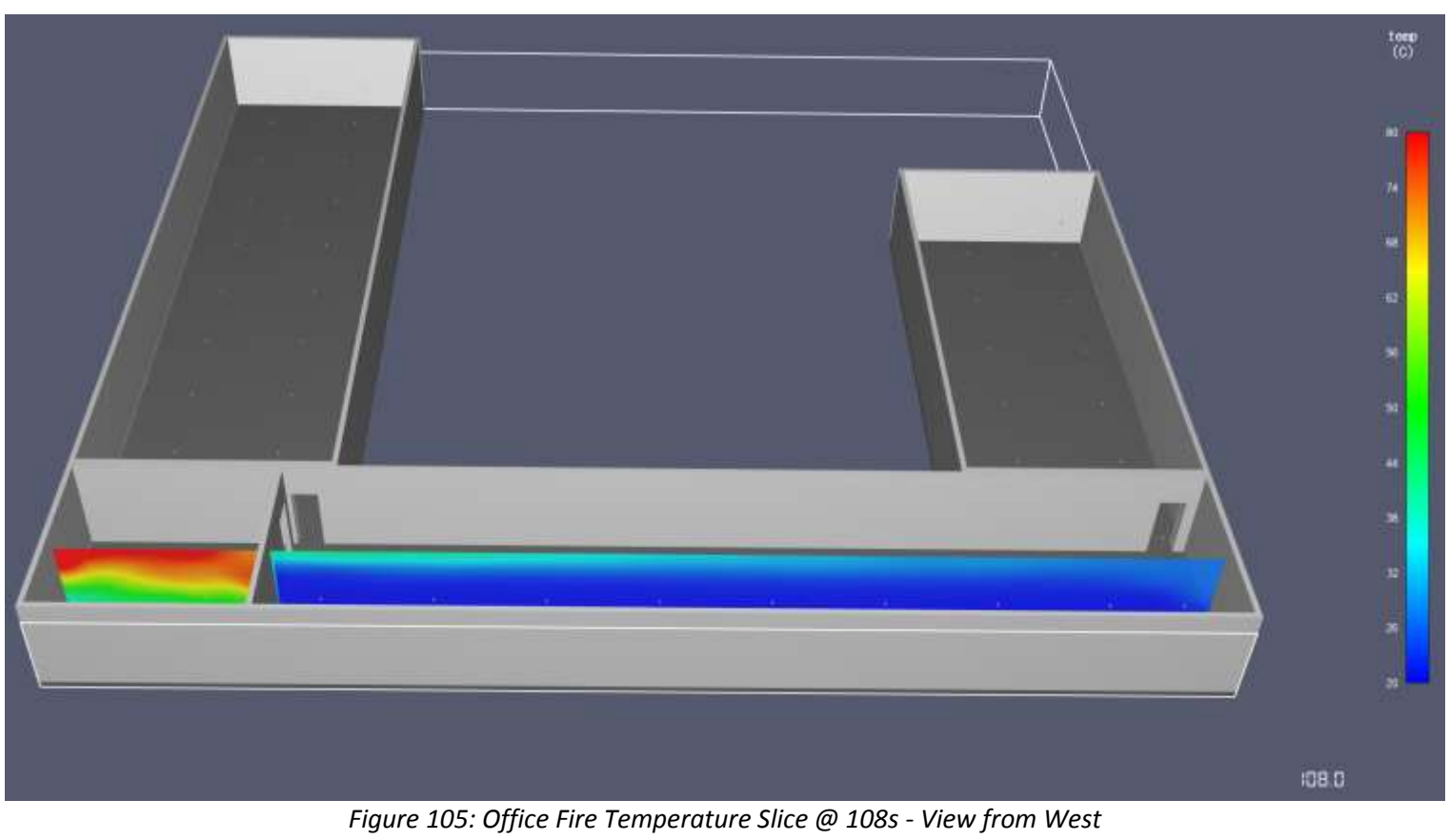


Figure 105: Office Fire Temperature Slice @ 108s - View from West

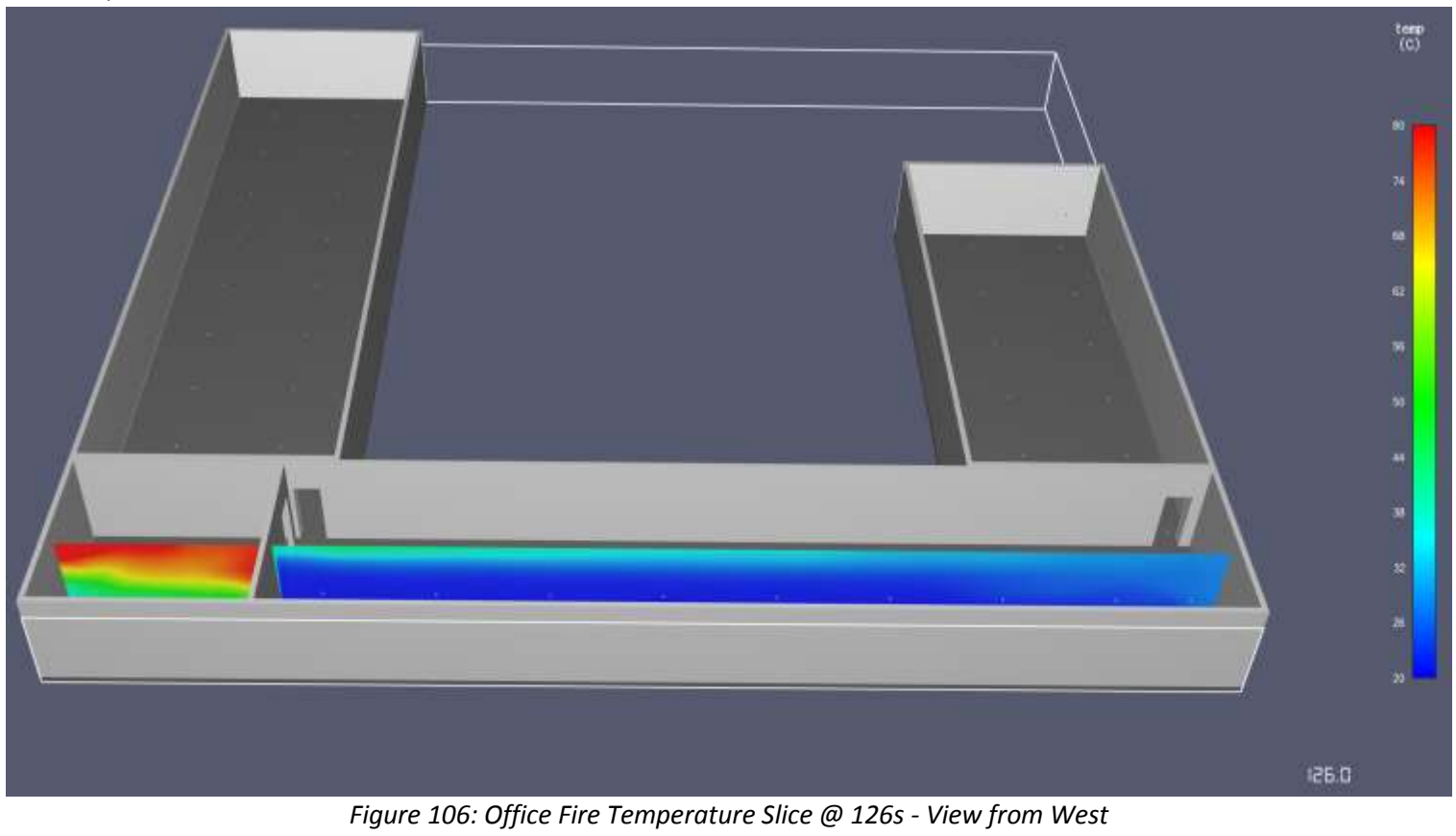


Figure 106: Office Fire Temperature Slice @ 126s - View from West